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# SITE-SPECIFIC TECHNICAL REPORT FOR FREE PRODUCT RECOVERY TESTING AT PUMP HOUSE 5, GRIFFISS AFB, NEW YORK

**DRAFT**

**PREPARED FOR:**

**AIR FORCE CENTER FOR ENVIRONMENTAL EXCELLENCE**
**TECHNOLOGY TRANSFER DIVISION**
**(AFCEE/ERT)**
**8001 ARNOLD DRIVE**
**BROOKS AFB, TEXAS 78235-5357**

**AND**

**305 SPTG/CEV**
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# SITE-SPECIFIC TECHNICAL REPORT (A003)

**for**

# FREE PRODUCT RECOVERY TESTING AT GRIFFISS AFB, NEW YORK

**by**

**A. Leeson, M. Place, and L. Cumming**

**for**

**Mr. Patrick Haas**
**U.S. Air Force Center for Environmental Excellence**
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**(AFCEE/ERT)**
**Brooks AFB, Texas 78235-5357**

**27 January 1997**

**Battelle**
**505 King Avenue**
**Columbus, Ohio 43201-2693**

**Contract No. F41624-94-C-8012**

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## ACRONYMS AND ABBREVIATIONS

| | |
|---|---|
| AFB | Air Force Base |
| AFCEE | U.S. Air Force Center for Environmental Excellence |
| bgs | below ground surface |
| BTEX | benzene, toluene, ethylbenzene, and xylenes |
| ft/ft | foot per foot |
| HC1 | hydrochloric acid |
| LNAPL | light-nonaqueous-phase liquid |
| MW | monitoring well |
| POL | petroleum, oils, and lubricants |
| ppmv | part(s) per million by volume |
| PVC | polyvinyl chloride |
| scfm | standard cubic foot (feet) per minute |
| TPH | total petroleum hydrocarbon |
| VOC | volatile organic compound |

## EXECUTIVE SUMMARY

This report summarizes the field activities conducted at Griffiss Air Force Base (AFB) for a short-term field pilot test to compare vacuum-enhanced free-product recovery (bioslurping) to traditional free-product recovery techniques used to remove light, nonaqueous-phase liquid (LNAPL) from subsurface soils and aquifers. The field testing at Griffiss AFB is part of the Bioslurper Initiative, which is funded and managed by the U.S. Air Force Center for Environmental Excellence (AFCEE) Technology Transfer Division. The AFCEE Bioslurper initiative is a multisite program designed to evaluate the efficacy of the bioslurping technology for (1) recovery of LNAPL from groundwater and the capillary fringe, and (2) enhancing natural in situ degradation of petroleum contaminants in the vadose zone via bioventing.

The main objective of the Bioslurper Initiative is to develop procedures for evaluating the potential for recovering free-phase LNAPL present at petroleum-contaminated sites. The overall study is designed to evaluate bioslurping and identify site parameters that are reliable predictors of bioslurping performance. To measure LNAPL recovery in a wide variety of in situ conditions, tests are being performed at many sites. The test at Griffiss is one of more than 40 similar field tests to be conducted at various locations throughout the United States and its possessions.

The intent of field testing is to collect data to support determination of the predictability of LNAPL recovery and to evaluate the applicability, cost, and performance of the bioslurping technology for removal of free product and remediation of the contaminated area. The on-site testing is structured to allow direct comparison of the LNAPL recovery achieved by bioslurping with the performance of more conventional LNAPL recovery technologies. The test method included an initial site characterization followed by LNAPL recovery testing. The three LNAPL recovery technologies tested at Griffiss AFB were skimmer pumping, bioslurping, and drawdown pumping.

Bioslurper pilot test activities were conducted at two monitoring wells at the POL Bulk Fuel Storage Area (Pump House 5): (1) monitoring well MW-7, and (2) monitoring well MW-3. Site characterization activities were conducted to evaluate site variables that could affect LNAPL recovery efficiency and to determine the bioventing potential of the site. Testing included baildown testing to evaluate the mobility of LNAPL, soil sampling to determine physical/chemical site characteristics, soil gas permeability testing to determine the radius of influence, and in situ respiration testing to evaluate site microbial activity.

Following the site characterization activities, the pump tests were conducted. At monitoring well MW-7, pilot tests for skimmer pumping, bioslurping, and drawdown pumping were conducted. The LNAPL recovery testing was conducted in the following sequence at monitoring well MW-7: 45.3 hr in the skimmer configuration, 92.7 hr in the bioslurper configuration, and 45.5 hr in the drawdown configuration.

After the drawdown pump test at MW-7, LNAPL recovery testing was conducted at monitoring well MW-3 for 139.4 hr in the bioslurper configuration.

Measurements of extracted soil gas composition, LNAPL thickness, and groundwater level were taken throughout the testing. The volume of LNAPL recovered and groundwater extracted were quantified over time.

Baildown recovery tests were conducted at monitoring wells MW-1, MW-3, MW-7, and MW-8. Baildown recovery tests provide a qualitative indication of the presence of mobile, free-phase LNAPL and recovery potential. Overall the baildown recovery tests indicated a relatively slow rate of LNAPL recovery into the wells. Also, short-term baildown recovery resulted in LNAPL thicknesses substantially less than initial apparent thicknesses. Monitoring well MW-8 recovered to an LNAPL thickness of 0.71 ft which is closer to the initial apparent thickness (1.11 ft). Monitoring well MW-7 had the highest initial apparent thickness (6.77 ft) and the highest rate of initial recovery. Based on these results, pilot testing was initiated on monitoring well MW-7.

Direct pumping tests were conducted at monitoring wells MW-7 and MW-3. Skimmer pump testing was conducted at monitoring well MW-7 in a continuous extraction mode for two days. No measurable free-phase LNAPL was recovered during the two days of skimmer pump testing, indicating that gravity-driven recovery is minimal. Bioslurper testing was conducted for two days resulting in relatively low recovery on the first day (1.2 gal/day) followed by no measurable product recovery on the second day. Vacuum levels in the well were high at 23 inches Hg. Groundwater production rates during bioslurping were higher than rates during the drawdown pump test, indicating that vacuum enhanced fluid recovery was in effect during the bioslurper test. The on-site water treatment equipment, consisting of a filter tank, oil/water separator, and clarification tanks, resulted in water effluent (2.8 to 3.5 mg/L total hydrocarbons) that is considered compatible with typical sanitary sewer discharge limits.

In an effort to determine if the results at monitoring well MW-7 were representative of site conditions, bioslurper testing was conducted at monitoring well MW-3. Minimal free-phase LNAPL was recovered on the first day of bioslurper pumping (1.65 gallons/day). No measurable LNAPL

free product was recovered on the second day of continuous extraction. The well head vacuum on monitoring well MW-3 (7 inches Hg) and groundwater production rate (1,100 gallons/day) were similar to those observed at monitoring well MW-7. Results at monitoring wells MW-7 and MW-3 appear to be representative of the site and indicate that gravity-driven or even vacuum-enhanced liquid recovery techniques are not feasible.

Drawdown testing was conducted to determine if a cone of groundwater depression would enhance LNAPL recovery. The water table was depressed in monitoring well MW-7 1.5 ft below the static water table. No measurable LNAPL free product was recovered in this mode during two days of continuous extraction. Groundwater recovery rates were on the order of 300 gallons/day. As stated above, the vacuum gradient maintained during the bioslurper test resulted in higher fluid recovery rates than the 1.5 ft groundwater drawdown test.

Bioslurping also promotes mass removal in the form of in situ biodegradation via bioventing and soil gas extraction. Vapor phase mass removal is the result of soil gas extraction as well as volatilization that occurs during the movement of LNAPL free product through the extraction network. Given, the measured vapor flowrate (6 scfm) and vapor concentrations, initial hydrocarbon removal rates were approximately 91 lb/day of TPH and 0.20 lb/day of benzene. Thus, initially, mass removal in the vapor phase is significant. However, this short-term test does not provide a good indication as to whether these rates would be sustained. Higher vapor mass removal rates are more often sustained at those sites where liquid product recovery is sustained.

The initial soil gas profiles at the site displayed oxygen-deficient, carbon dioxide-rich, high total volatile hydrocarbon vapor conditions across the 4 to 10 ft below ground surface horizons. These conditions indicate that natural biodegradation of residual petroleum hydrocarbons has occurred, but is limited by oxygen availability. Soil gas concentrations were measured during the bioslurper test at monitoring points adjacent to monitoring well MW-7 to determine if the vadose zone was being oxygenated via the bioslurper action. Oxygen concentrations were most influenced at monitoring point MP1, 10 ft from the bioslurper well. Based on the soil gas permeability test, where a radius of influence of 38 ft was measured, it is likely that these areas will become fully aerated. In short, a two day extraction time frame at 6 scfm is insufficient to exchange sufficient pore volumes of soil gas to fully oxygenate the zone of influence. In situ biodegradation rates of 5.8 to 11 mg/kg-day were measured at three different locations. Based on the radius of influence of 38 ft and a hydrocarbon-impacted soil thickness of 18 ft, mass removal rates via biodegradation are on the order of 43 to 81 lbs of hydrocarbon per day. Thus, mass removal rates via biodegradation could be as

significant as the initial vapor phase removal rates measured during the bioslurper test. These results indicate that bioventing is feasible at this site. Air injection bioventing is preferable over bioslurping and soil vapor extraction with respect to the elimination of hydrocarbon vapor emissions.

In summary, the on-site testing at Pump House 5, Griffiss AFB, included the direct testing of gravity-driven and vacuum-driven LNAPL free product recovery techniques, bioventing, physical sampling, and tests relevant to soil vapor extraction. Liquid phase recovery was not sustainable in any of the extraction modes. The vacuum-enhanced mode is significant in that if liquid phase LNAPL recovery is not sustainable under high vacuum conditions, then it is unlikely that it will be sustainable under any conditions. Vapor phase mass removal rates measured during bioslurper testing may be the result of soil gas removal (i.e. SVE) or volatilization during liquid entrainment. The generation of off-gas is undesirable and sustained rates of off-gas discharge cannot be estimated accurately from this test. The in situ respiration test and vadose zone radius of influence testing demonstrate that bioventing is feasible at this site.

Periodic baildown recovery tests are recommended as a useful indicator of LNAPL free product recovery potential. Based on the conduct of identical pilot tests at over 25 different sites, there have been several sites where apparent LNAPL product thicknesses are significant (>3 ft). However, once the LNAPL free product is removed from the well, it may take weeks or months to return to initial apparent thicknesses. LNAPL free product continues to accumulate in monitoring wells, but not at a rate to make free product recovery worthwhile. The periodic baildown recovery test is the best method to verify whether or not the Pump House 5 site is like the sites described above. Periodic hand bailing may also represent removing LNAPL free product to the extent practicable.

This pilot test effort is a logical follow-on to the AFCEE/ERT intrinsic remediation investigation conducted at Pump House #5. The "Intrinsic Remediation Report" recommended the consideration of source removal, and this free product recovery pilot test was designed to determine the feasibility of some of the most effective technologies and select the best method of source removal. Further consideration should be given to an overall risk management strategy to include natural attenuation, and the evaluation of soil vapor extraction via internal combustion engine (ICE) (AFCEE/ERT ICE Report, 1994), bioventing, and periodic baildown recovery tests.

# DRAFT SITE-SPECIFIC TECHNICAL REPORT (A003)
# for
# FREE PRODUCT RECOVERY TESTING AT GRIFFISS AFB, NEW YORK
**27 January 1997**

## 1.0 INTRODUCTION

This report describes activities performed and data collected during field tests at Griffiss Air Force Base (AFB), New York to compare vacuum-enhanced free-product recovery (bioslurping) to traditional free-product recovery technologies for removal of light, nonaqueous-phase liquid (LNAPL) from subsurface soils and aquifers. The field testing at Griffiss AFB is part of the Bioslurper Initiative, which is funded and managed by the U.S. Air Force Center for Environmental Excellence (AFCEE) Technology Transfer Division. The AFCEE Bioslurper Initiative is a multisite program designed to evaluate the efficacy of the bioslurping technology for (1) recovery of LNAPL from groundwater and the capillary fringe and (2) enhancing natural in situ degradation of petroleum contaminants in the vadose zone via bioventing.

### 1.1 Objectives

The main objective of the Bioslurper Initiative is to develop procedures for evaluating the potential for recovering free-phase LNAPL present at petroleum-contaminated sites. The overall study is designed to evaluate bioslurping and identify site parameters that are reliable predictors of bioslurping performance. To measure LNAPL recovery in a wide variety of in situ conditions, tests are being performed at many sites. The test at Griffiss AFB is one of more than 40 similar field tests to be conducted at various locations throughout the United States and its possessions. Aspects of the testing program that apply to all sites are described in the *Test Plan and Technical Protocol for Bioslurping* (Battelle, 1995). Test provisions specific to activities at Griffiss AFB are described in the Site-Specific Test Plan provided in Appendix A.

The intent of field testing is to collect data to support determination of the predictability of LNAPL recovery and to evaluate the applicability, cost, and performance of the bioslurping technology for removal of free product and remediation of the contaminated area. The on-site testing is structured to allow direct comparison of the LNAPL recovery achieved by bioslurping with the

performance of more conventional LNAPL recovery technologies. The test method included an initial site characterization followed by LNAPL recovery testing. The three LNAPL recovery technologies tested at Griffiss AFB were skimmer pumping, bioslurping, and drawdown pumping. The specific test objectives, methods, and results for the Griffiss AFB test program are discussed in the following sections.

### 1.2 Testing Approach

Bioslurper pilot test activities were conducted at two monitoring wells at Pump House 5: (1) monitoring well MW-7, and (2) monitoring well MW-3. Site characterization activities were conducted to evaluate site variables that could affect LNAPL recovery efficiency and to determine the bioventing potential of the site. Testing included baildown testing to evaluate the mobility of LNAPL, soil sampling to determine physical/chemical site characteristics, soil gas permeability testing to determine the radius of influence, and in situ respiration testing to evaluate site microbial activity.

Following the site characterization activities, the pump tests were conducted. At monitoring well MW-7, pilot tests for skimmer pumping, bioslurping, and drawdown pumping were conducted. The LNAPL recovery testing was conducted in the following sequence at monitoring well MW-7: 45.3 hr in the skimmer configuration, 92.7 hr in the bioslurper configuration, and 45.5 hr in the drawdown configuration.

After the drawdown pump test at MW-7, LNAPL recovery testing was conducted at monitoring well MW-3 for 139.4 hr in the bioslurper configuration.

Measurements of extracted soil gas composition, LNAPL thickness, and groundwater level were taken throughout the testing. The volume of LNAPL recovered and groundwater extracted were quantified over time.

## 2.0 SITE DESCRIPTION

The site description information presented in this section was obtained from the *Work Plan for a Treatability Study in Support of the Intrinsic Remediation (National Attenuation) Option at Pumphouse 5 (Building 771)* prepared for the AFCEE and Griffiss AFB by Parsons Engineering

Science, Inc., June 1995. Additional information was obtained from *Building 771 (Pumphouse 5) Engineering Evolution/Cost Analysis Report* dated February 1995.

Griffiss AFB is located in central New York State and is bordered on the west by the city of Rome (Figure 1). The base is surrounded by land used for agricultural, residential, commercial, and industrial purposes. The 3,900 contiguous acres are located in the Mohawk River Valley.

The base has been in operation since February 1942, with the primary mission of maintaining and implementing effective aerial refueling operations and providing bombardment capabilities. Pumphouse 5, the area identified as a source Area of Concern (AOC), serves as a fuel storage and transfer station for aircraft refueling operations (Figure 2).

Pumphouse 5 is part of the base fuel distribution system. Located in the vicinity of Pumphouse 5 are four 50,000-gallon underground storage tanks (USTs) containing JP-4 jet fuel, of which an unknown number are found below the water table (Figure 3). Northwest of Pumphouse 5 are two valve pits and a 2,000-gallon collection tank. A drainage ditch located 250 ft north of the pumphouse is a potential receptor of groundwater discharge.

There are records of three large spills known to have contributed to contamination at the site. Fuel released from an aircraft fire in 1977 was the cause of a Class III JP-4 spill. Griffiss AFB personnel indicated that the fuel was discharged off site due to an open trench gate in the center of the apron. An occurrence reported in 1989 was the result of indications of free-phase fuel product found in samples from monitoring wells at Pumphouse 5. A Class III JP-4 spill again occurred in 1991 between the fillstand and Pumphouse 5. Sorbent material was used to clean up the spill.

Attempts have been made to define the limits of contamination through leak detection investigations and a soil gas survey. Three monitoring wells were installed in 1989, and an additional seven wells were installed in 1991. In each of the wells where free product was observed, a flexible axial peristaltic pump petroleum-skimming system was used to draw down free product. This operation was begun in early 1993 and, in conjunction with hand bailing, removed 25 to 50 gallons of free product in 6 months. Since this time, several other incidences have contributed to further contamination. Personnel report that the 2,000-gallon fuel collection tank has been overfilled on occasions in the past. Furthermore, a leak attributed to a broken fitting in the pipe connecting the collection tank in the pumphouse floor drain was discovered in 1994.

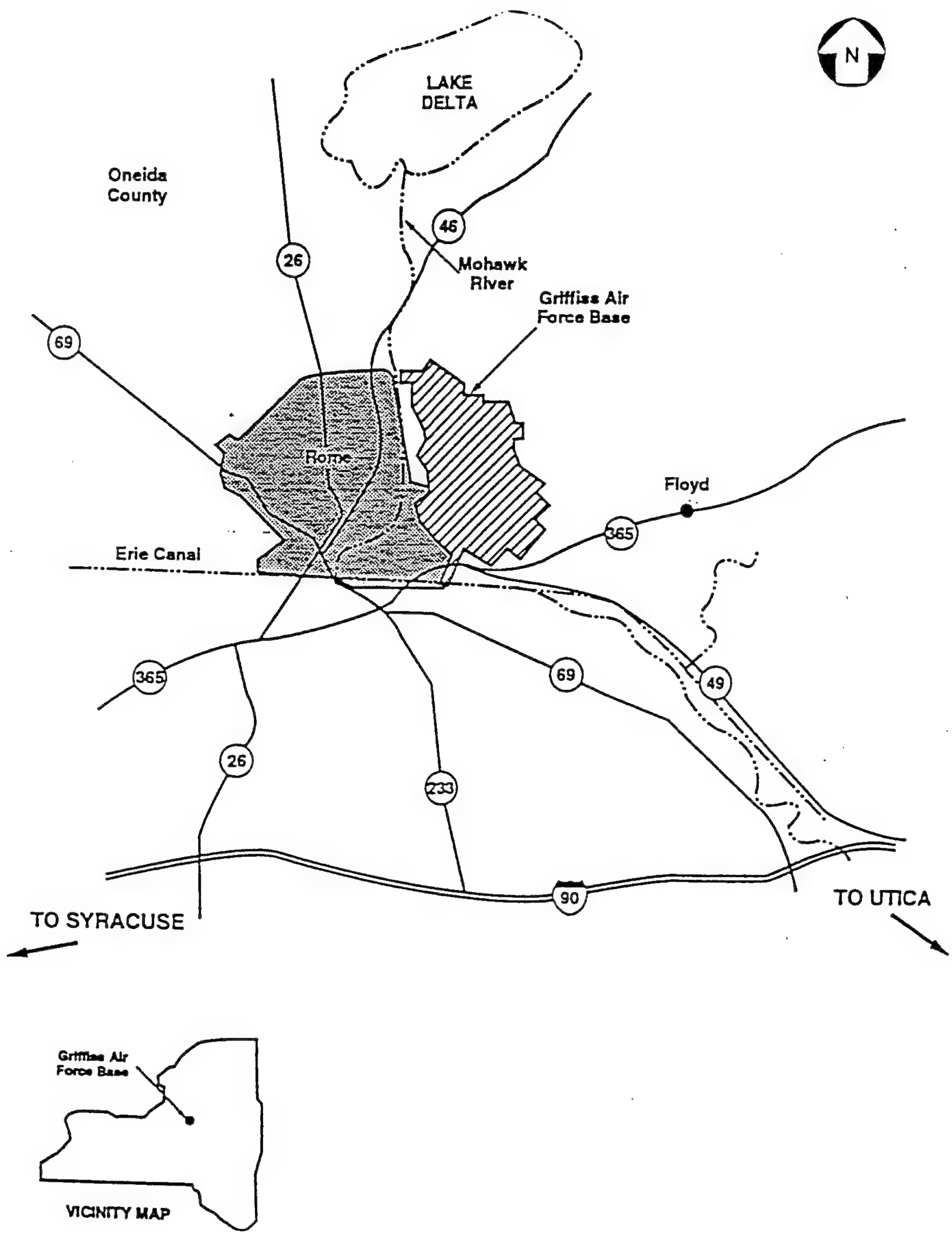


**Figure 1. Map Showing Location of Griffiss AFB, NY**

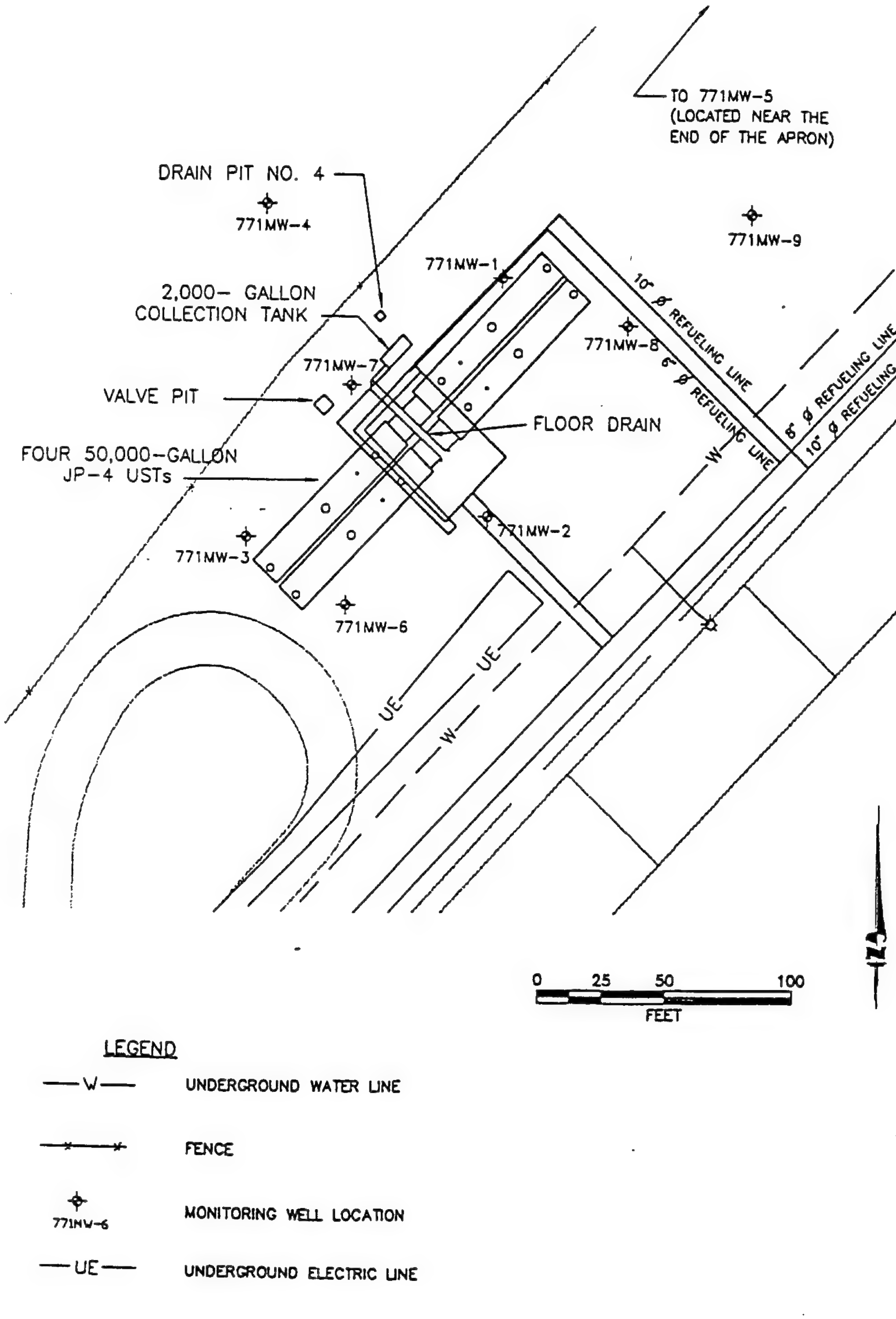


**Figure 2. Map Showing Location of Pumphouse 5, Griffiss AFB, NY**

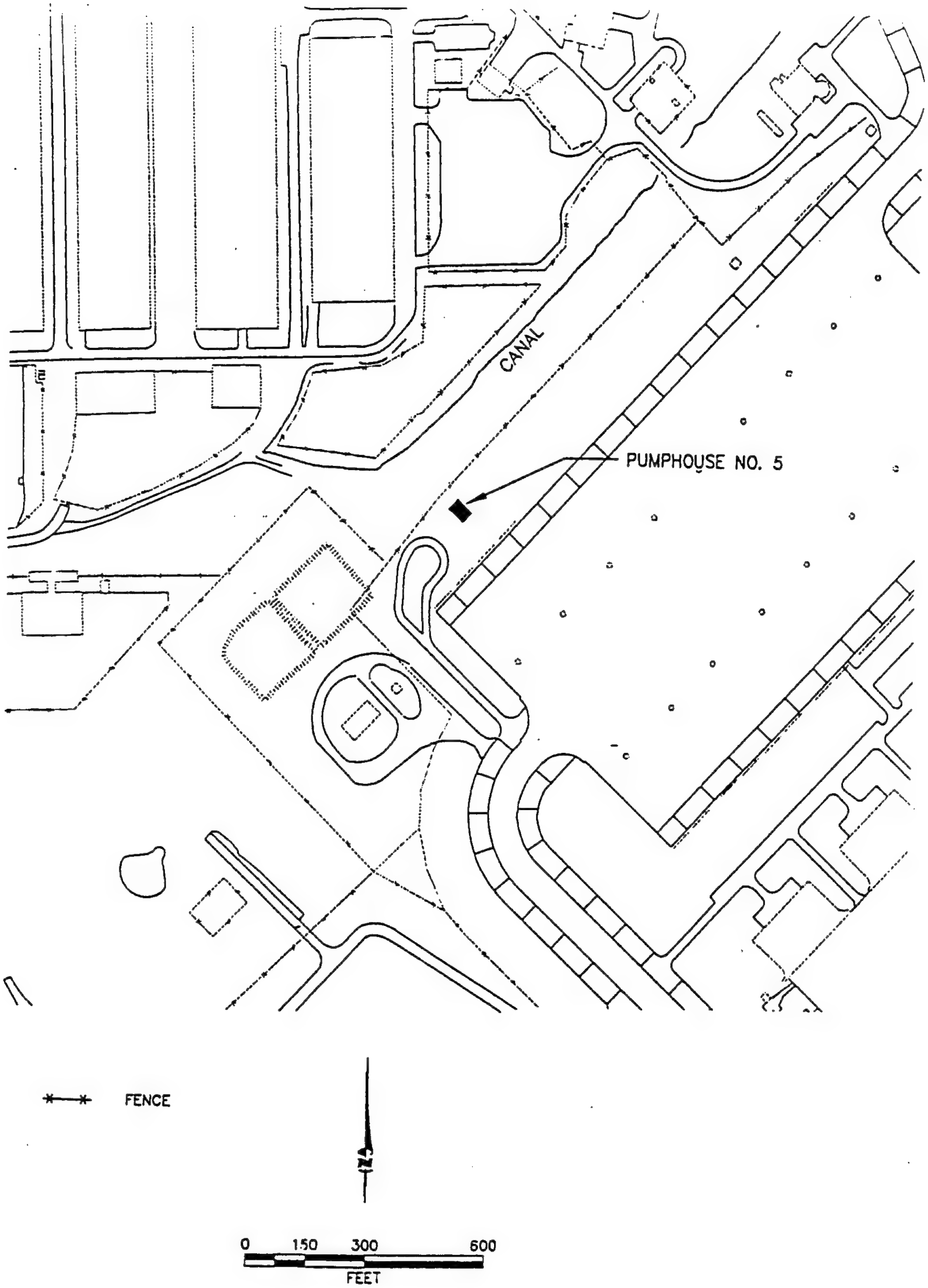


**Figure 3. Site Map of Pumphouse 5, Griffiss AFB, NY**

## 2.1 Site Geology

Griffiss AFB and its vicinity rest on hundreds of feet of shale bedrock covered by unconsolidated materials of coarser texture described as gray sandy shale. From south to north, the area tends to demonstrate a coarsening of sediments and a decreasing depth to bedrock.

Site soils consist of silty sands underlain by glacial till in the east- and west-central areas with the remainder of the site consisting of gravels. The southern portion is underlain by well-sorted sands.

Pumphouse 5 is described as having fine- to medium-grained sand, gravel, and traces of clay. These sands tend to dominate both the vadose and saturated zones with the exception of clayey soils observed at 12 to 19 ft below ground surface (bgs) at several boreholes. Depth to bedrock ranges from 25 to 50 ft bgs at the site area.

## 2.2 Aquifer Characteristics

Groundwater is generally found between 14 and 19 ft bgs across the site and at shallower depths in adjacent areas. Flow tends to be counter-regional to the southwesterly groundwater flow pattern of the base. The northern portion of the site experiences north and northwest flow throughout the year with possible discharge into a drainage ditch located 250 ft northwest of the pumphouse. The flow direction to the south of the pumphouse is predominantly north; however, some localized flow patterns develop specific to the seasons. Flow direction to the east of the pumphouse tends to be erratic.

The average hydraulic gradient across the site has been estimated at 0.060 ft/ft. Both rising- and falling-head slug test data were used to measure hydraulic conductivity. These values were found to be $3.03 \times 10^{-3}$ ft/min respectively. Using these data and assumed porosity of 30%, the groundwater velocity at the site is estimated to be $4,38 \times 10^{-4}$ ft/min or 0.63 ft/day.

## 2.3 Site Contamination

Site contamination in the form of JP-4 jet fuel was first detected in 1989 by the appearance of free product in the monitoring wells. LNAPL thicknesses in monitoring wells, which continued to be monitored until 1995, ranged from 0.010 to 5.07 ft. Samples from a soil gas survey performed at the

end of 1989 were analyzed for benzene, toluene, ethylbenzene, and xylenes (BTEX) and total petroleum hydrocarbons (TPH). In one contaminated area, BTEX levels of 706 $\mu$g/L and TPH concentrations of 104,000 $\mu$g/L were detected. TPH concentrations northwest and northeast of the site reached as high as 219,000 $\mu$g/L, respectively,

Analysis of free product floating on groundwater was indicative of JP-4 with variances due to slight environmental exposure. Data from the May 1994 sampling also indicate that the contamination was relatively fresh. Locations of the mobile LNAPL seem to correspond to buried tanks and fuel lines and show that free product seems to have migrated northwest to a constructed drainage ditch.

A four-quarter groundwater sampling series began in 1992. During this time period, the highest BTEX levels were recorded at 771MW-4 and 771MW-8, with respective readings ranging from 3,427 to 8,529 $\mu$g/L and 11,180 to 30,600 $\mu$g/L. Other contaminants detected at the site include acetone at 4,300 $\mu$g/L, naphthalene at 118.3 $\mu$g/L, and total glycol at 0.93 mg/L. The groundwater quality standards for New York are the applicable or relevant and appropriate requirements (ARARs) assigned to the Pumphouse 5 area. BTEX concentrations exceeded the ARARs in at least one or more wells for all four sampling periods.

## 3.0 BIOSLURPER SHORT-TERM PILOT TEST METHODS

This section documents the initial conditions at the test site and describes the test equipment and methods used for the short-term pilot test at Griffiss AFB.

### 3.1 Initial LNAPL/Groundwater Measurements and Baildown Testing

Monitoring wells MW-1, MW-3, MW-7, and MW-8 were evaluated for use in the bioslurper pilot testing. Initial depths to LNAPL and to groundwater were measured using an oil/water interface probe (ORS Model #1068013). LNAPL was removed from the well with a Teflon™ bailer until the LNAPL thickness could no longer be reduced. The rate of increase in the thickness of the floating LNAPL layer was monitored using the oil/water interface probe for approximately 0.5 hr at monitoring well MW-1, approximately 1 hr at monitoring well MW-3, approximately 19 hr at monitoring well MW-7, and for approximately 0.5 hr at monitoring well MW-8.

An LNAPL sample was collected from monitoring well MW-7 for analysis of BTEX and for boiling point fractionation. The sample was sent to Alpha Analytical, Inc., in Sparks, Nevada for analysis.

### 3.2 Well Construction Details

Short-term bioslurper pump tests were conducted at existing monitoring well MW-7 and at monitoring well MW-3. Monitoring wells MW-7 and MW-3 are constructed of 2-inch-diameter, schedule 40 polyvinyl chloride (PVC). A schematic diagram illustrating general well construction details for monitoring wells MW-7 and MW-3 is provided in Figure 4. Precise construction details for the total well depth and screen length are currently unknown.

### 3.3 Soil Gas Monitoring Point Installation

Three monitoring points were installed and labeled MP1, MP2, and MP3. The locations and constructions details of the monitoring points are illustrated in Figure 4.

The monitoring points consisted of ¼-inch tubing, with 1-inch-diameter, 6-inch-long screened areas. The screened lengths were positioned at depths of 6, 8, and 10 ft bgl at monitoring points MP1 and MP3 and at depths of 4, 6, and 8 ft bgl at monitoring point MP2. The annular space corresponding to the screened length was filled with silica sand. The interval from the top of the screened length to the bottom of the next screened length, as well as the interval from the ground surface to the top of the first screened length, was filled with bentonite clay chips. After placement, the bentonite clay was hydrated with water to expand the chips and provide a seal.

Type K thermocouples were installed with monitoring point MP2 at depths of 4 and 8 ft bgl.

After installation of the monitoring points, initial soil gas measurements were taken with a GasTech portable $O_2$/$CO_2$ meter and a GasTech TraceTechtor portable hydrocarbon meter. Oxygen limitation was observed at all monitoring points, with oxygen concentrations below 5% and TPH concentrations greater than 20,000 ppmv (Table 1).

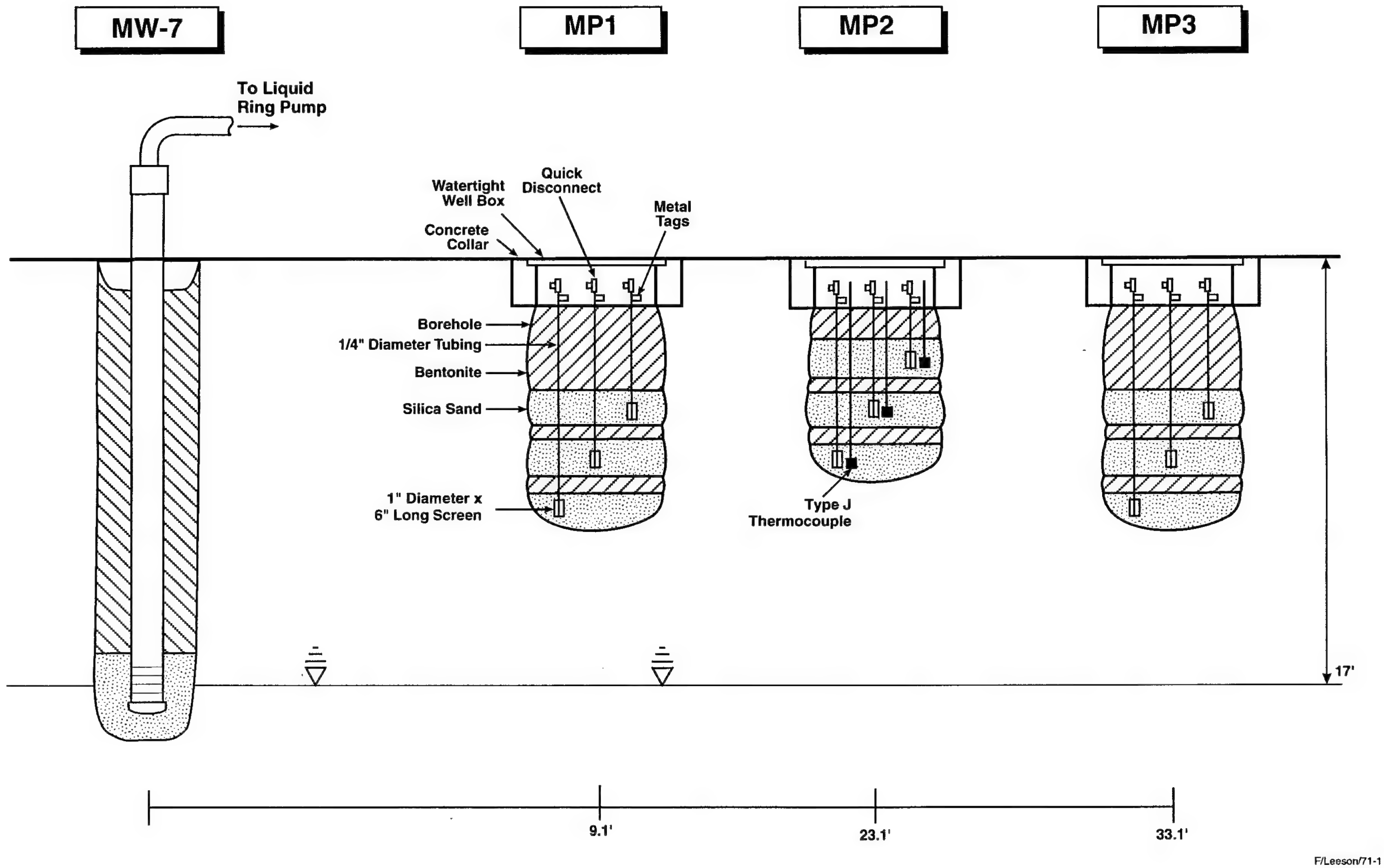


Figure 4. Construction Details of Monitoring Well MW-7 and Soil Gas Monitoring Points at Griffiss AFB, NY

**Table 1. Initial Soil-Gas Compositions at Griffiss AFB, NY**

| Monitoring Point | Depth (ft) | Oxygen (%) | Carbon Dioxide (%) | TPH (ppmv) |
|---|---|---|---|---|
| MP1 | 6.0 | 0 | 8.0 | >20,000 |
| | 8.0 | 0 | 8.5 | >20,000 |
| | 10 | 0 | 8.5 | >20,000 |
| MP2 | 4.0 | 0 | 8.0 | >20,000 |
| | 6.0 | 0 | 9.0 | >20,000 |
| | 8.0 | 0 | 9.0 | >20,000 |
| MP3 | 6.0 | 0 | 14 | >20,000 |
| | 8.0 | 0 | 11 | >20,000 |
| | 10 | 2.0 | 4.0 | >20,000 |

## 3.4 Soil Sampling and Analysis

Two soil samples were collected during the installation of monitoring point MP1 and were labeled GRF-A1 and GRF-A2. The samples were taken from 8.0 to 9.0 ft bgs using a split spoon sampler with brass sleeves. The samples were placed in an insulated cooler, chain-of-custody records and shipping papers were completed, and the samples were sent to Alpha Analytical, Inc., in Sparks, Nevada. Samples were analyzed for BTEX, bulk density, moisture content, particle size, porosity, and TPH-purgeable. The laboratory analytical report is provided in Appendix B.

## 3.5 LNAPL Recovery Testing

### 3.5.1 System Setup

The bioslurping pilot test system is a trailer-mounted mobile unit. The vacuum pump (Atlantic Fluidics Model A100, 10-hp liquid ring pump), oil/water separator, and required support equipment were carried to the test location on a trailer. The trailer was located near the monitoring well, the well cap was removed, a well seal was placed on the top of the well, and the slurper tube was

lowered into the well. The slurper tube was attached to the vacuum pump. Different configurations of the well seal and the placement depth of the slurper tube allow for simulation of skimmer pumping, operation in the bioslurping configuration, or simulation of drawdown pumping. Extracted groundwater was treated by passing the recovered fluid through two oil/water separators. The groundwater was discharged into the City of Rome sanitary sewer system.

A brief system startup test was performed prior to LNAPL recovery testing to ensure that all system components were working properly. The system checklist is provided in Appendix C. All site data and field testing information were recorded in a field notebook and then transcribed onto pilot test data sheets provided in Appendix D.

### 3.5.2 Skimmer Pump Test

Prior to test initiation, depths to LNAPL and groundwater were measured. The slurper tube was then set at the LNAPL/groundwater interface with the wellhead open to the atmosphere. The drop tube was held in position by the well seal, and was positioned to leave the wellhead vented to the atmosphere (Figure 5). The liquid ring pump and oil/water separator were primed with known amounts of groundwater to ensure that any LNAPL or groundwater entering the system could be quantified. The flow totalizer for the LNAPL and aqueous effluent were zeroed, and the liquid ring pump was started on 20 August 1996 to begin the skimmer pump test. The test was operated continuously for 45.3 hr. The LNAPL and groundwater extraction rates were monitored throughout the test, as were all other relevant data for the skimmer pump test. Test data sheets are provided in Appendix D.

### 3.5.3 Bioslurper Pump Test

Two bioslurper pump test were conducted: one at monitoring well MW-7 and one at monitoring well MW-3. Details of the tests are described in the following sections.

#### 3.5.3.1 Monitoring Well MW-7

Upon completion of the skimmer pump test, preparations were made to begin the bioslurper pump test. The slurper tube was set at the LNAPL/groundwater interface. The LNAPL and

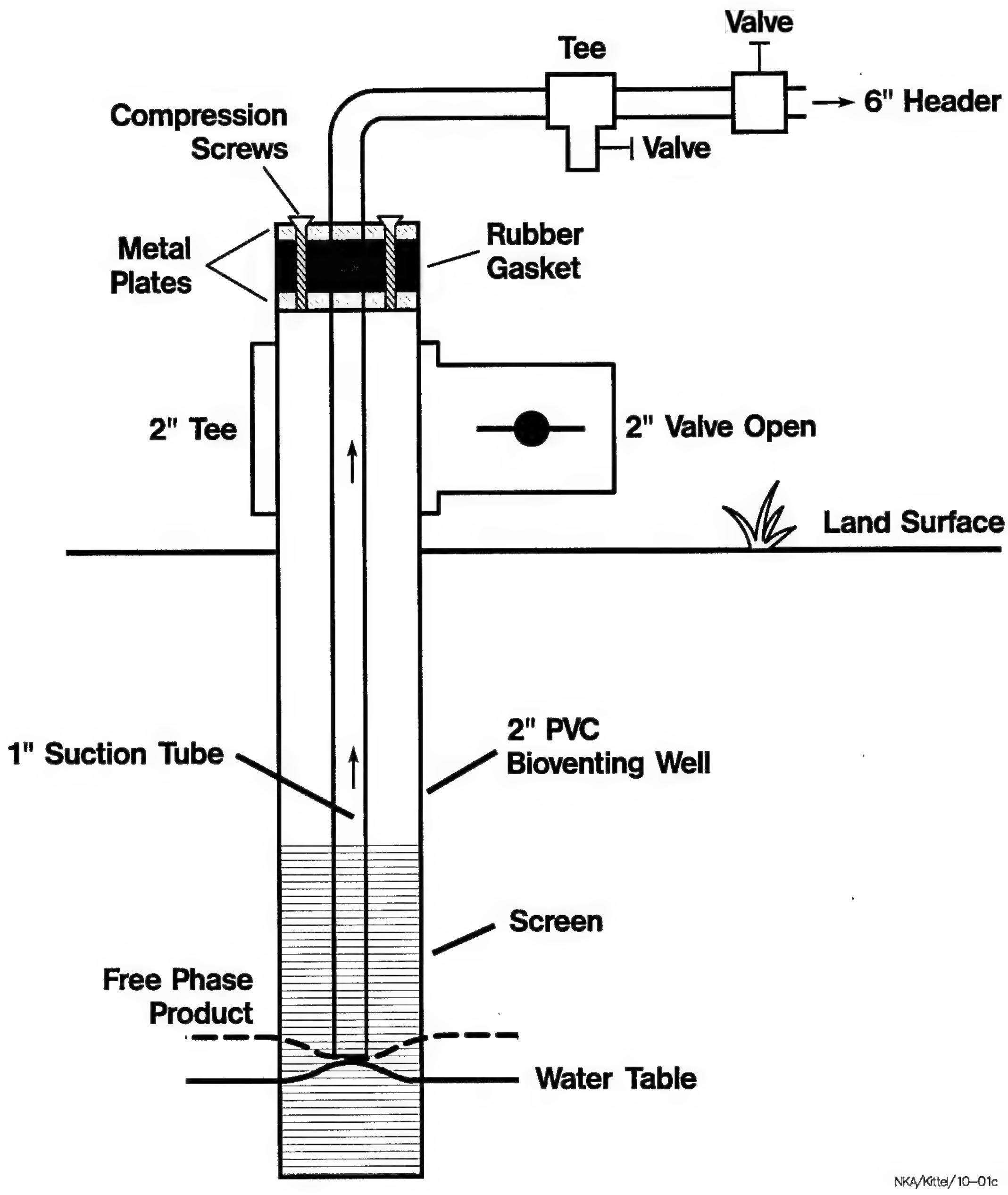


Figure 5. Slurper Tube Placement and Valve Position for the Skimmer Pump Test

groundwater depth were measured prior to any recovery testing. The sanitary well seal was positioned inside the well, sealing the wellhead and allowing the pump to establish a vacuum in the well (Figure 6). A pressure gauge was installed at the wellhead to measure the vacuum inside the extraction well. The liquid ring pump was started on 22 August 1996 to begin the bioslurper pump test. The test was initiated approximately 11 hr after the skimmer pump test and was operated for 92.7 hr. The LNAPL and groundwater extraction rates were monitored throughout the test, as were all other relevant data for the bioslurper pump test. The data sheets are provided in Appendix D.

#### 3.5.3.2 Monitoring Well MW-3

The liquid ring pump was started on 24 August 1996 to begin the bioslurper pump test. The test was initiated approximately 1 hr after termination of the bioslurper pump test at MW-7. The LNAPL and groundwater extraction rates were monitored throughout the test, as were all other relevant data for the bioslurper pump test. Test data sheets are provided in Appendix D.

### 3.5.4 Drawdown Pump Test

Upon completion of the bioslurper pump test at MW-3, preparations were made to begin the drawdown pump test. Drawdown testing was conducted to determine if a cone of groundwater depression would enhance LNAPL recovery. The slurper tube was positioned 1.5 ft below the initial LNAPL/water interface measured prior to any recovery pump testing (Figure 7). The liquid ring pump was started on 26 August 1996 to begin the drawdown pump test. The test was initiated approximately 8 hr after the bioslurper pump test was completed and was operated continuously for 45.5 hr. The LNAPL and groundwater extraction rates were monitored throughout the test, as were all other relevant data for the drawdown pump test. Test data sheets are provided in Appendix D.

## 3.6 Off-Gas Sampling and Analysis

Two soil gas samples were collected during the bioslurper pump test. Samples GRF-OGS-1 and GRF-OGS-2 were collected from the bioslurper off-gas during the bioslurper pump test at monitoring well MW-7. Sample GRF-OGS-1 was collected following approximately 58 hr of operation, and sample GRF-OGS-2 was collected after approximately 79 hr of operation. The

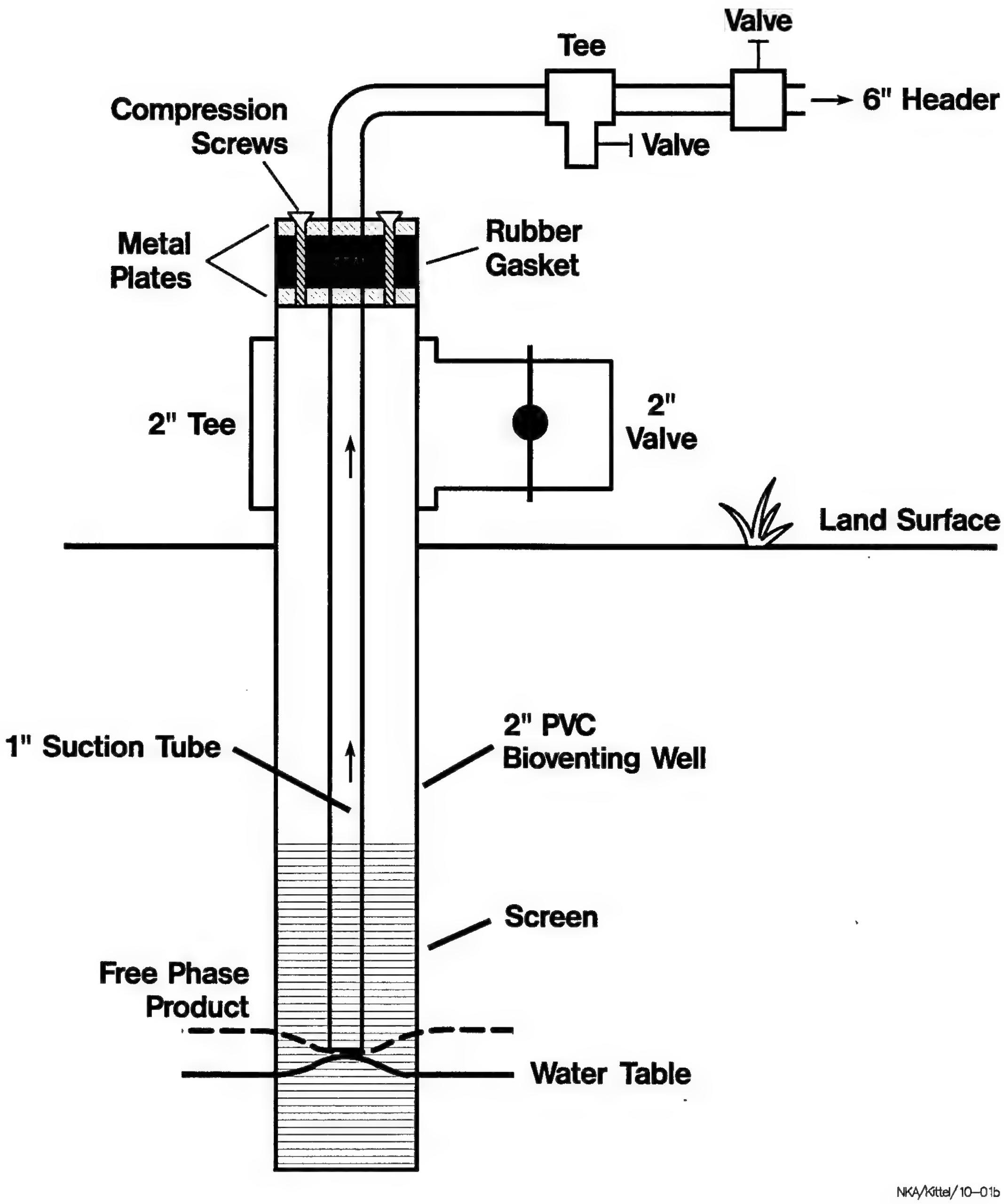


**Figure 6. Slurper Tube Placement for the Bioslurper Pump Test**

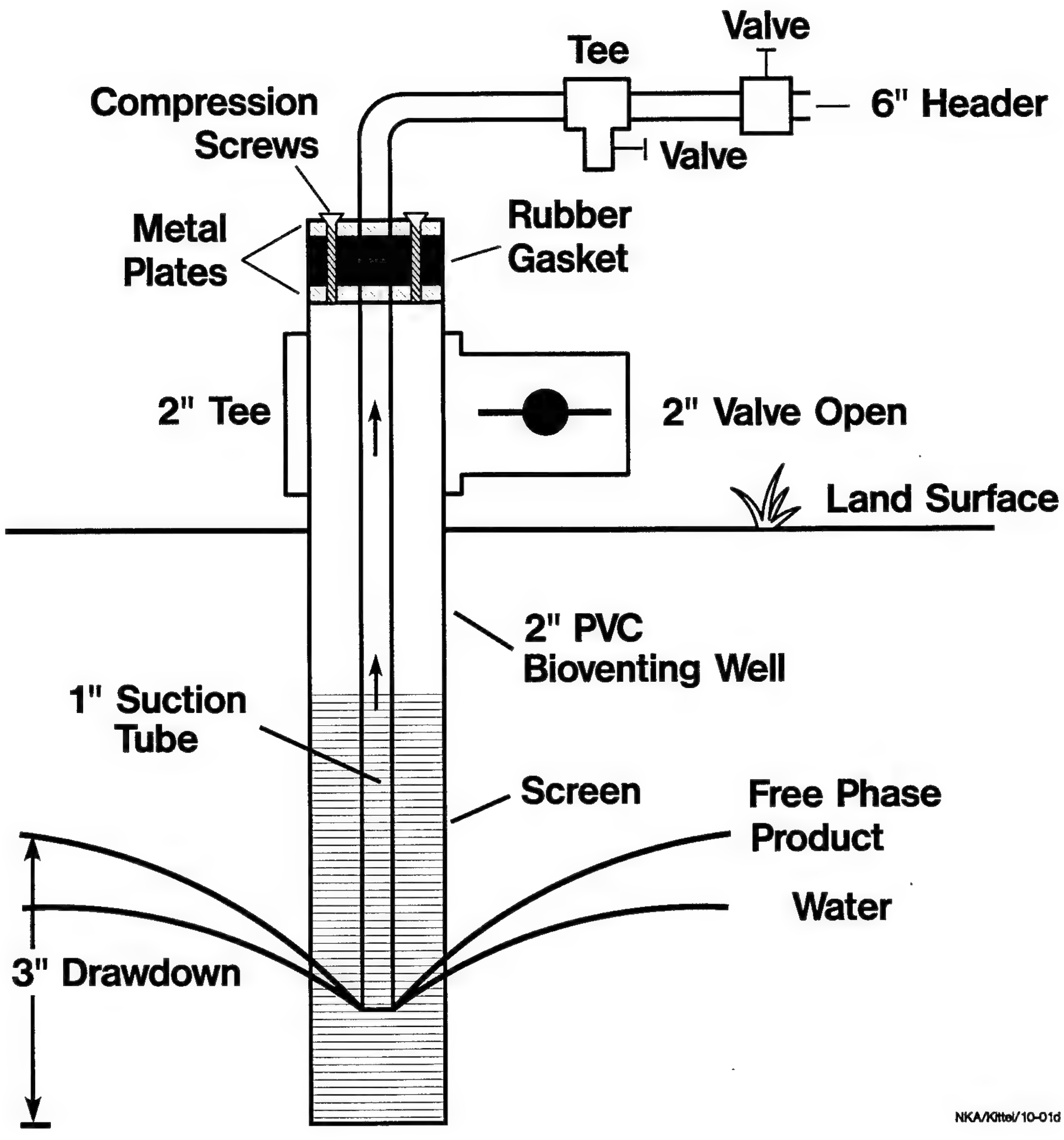


Figure 7. Slurper Tube Placement for Drawdown Pump Test

samples were collected in Summa™ canisters. The samples were sent under chain of custody to Air Toxics, Ltd., in Folsom, California, for analyses of BTEX and TPH, using EPA Method TO-3.

### 3.7 Groundwater Sampling and Analysis

Two groundwater samples were collected during the bioslurper pump test at MW-7 and were labeled GFS-DW-1 and GFS-DW-2. Each sample was collected after the oil/water separator, after approximately 59 and 79 hr of operation, respectively. Samples were collected in 40-mL septa vials containing hydrochloric acid (HC1) preservative. Samples were checked to ensure no headspace was present and were then shipped on ice and sent under chain of custody to Alpha Analytical, Inc., in Sparks, Nevada for analyses of BTEX and TPH (purgeable).

### 3.8 Soil Gas Permeability Testing

The soil gas permeability test data were collected during the bioslurper pump test at monitoring well MW-7. Before a vacuum was established in the extraction well, the initial soil gas pressures at the three installed monitoring points were recorded. The start of the bioslurper pump test created a steep pressure drop in the extraction well which was the starting point for the soil gas permeability testing. Soil gas pressures were measured at each of the three monitoring points at all depths to track the rate of outward propagation of the pressure drop in the extraction well. Soil gas pressure data were collected frequently during the first 20 minutes of the test. The soil gas pressures were recorded throughout the bioslurper pump test to determine the bioventing radius of influence. Test data are provided in Appendix E.

### 3.9 In Situ Respiration Testing

Air containing approximately 2% helium was injected into three monitoring points for approximately 24 hr beginning on 26 August 1996. The setup for the in situ respiration test is described in the *Test Plan and Technical Protocol a Field Treatability Test for Bioventing* (Hinchee et al., 1992). A ½-hp diaphragm pump was used for air and helium injection. Air and helium were injected through monitoring points MP1-10.0′, MP2-8.0′, and MP3-10.0′. After the air/helium injection was terminated, soil gas concentrations of oxygen, carbon dioxide, TPH, and helium were

monitored periodically. The in situ respiration test was terminated on 28 August 1996. Oxygen utilization and biodegradation rates were calculated as described in Hinchee et al. (1992). Raw data for these tests are presented in Appendix F.

Helium concentrations were measured during the in situ respiration test to quantify helium leakage to or from the surface around the monitoring points. Helium loss over time is attributable to either diffusion through the soil or leakage. A rapid drop in helium concentration usually indicates leakage. A gradual loss of helium along with a first-order curve generally indicates diffusion. As a rough estimate, the diffusion of gas molecules is inversely proportional to the square root of the molecular weight of the gas. Based on molecular weights of 4 for helium and 32 for oxygen, helium diffuses approximately 2.8 times faster than oxygen, or the diffusion of oxygen is 0.35 times the rate of helium diffusion. As a general rule, we have found that if helium concentrations at test completion are at least 50 to 60% of the initial levels, measured oxygen uptake rates are representative. Greater helium loss indicates a problem, and oxygen utilization rates are not considered representative.

# 4.0 RESULTS

This section documents the results of the site characterization, the comparative LNAPL recovery pump test, and other supporting tests conducted at Griffiss.

## 4.1 Baildown Test Results

Results from the baildown tests are presented in Table 2. Baildown recovery tests were conducted at monitoring wells MW-1, MW-3, MW-7, and MW-8. Baildown recovery tests provide a qualitative indication of the presence of mobile, free-phase LNAPL and recovery potential. Overall the baildown recovery tests indicated a relatively slow rate of LNAPL recovery into the wells. Also, short-term baildown recovery resulted in LNAPL thicknesses substantially less than initial apparent thicknesses. Monitoring well MW-8 recovered to an LNAPL thickness of 0.71 ft which is closer to the initial apparent thickness (1.11 ft). Monitoring well MW-7 had the highest initial apparent thickness (6.77 ft) and the highest rate of initial recovery. Based on these results, pilot testing was initiated on monitoring well MW-7.

Table 2. Results of Baildown Testing, Griffiss AFB, NY

| Monitoring Well | Sample Collection Time | Depth to Groundwater (ft) | Depth to LNAPL (ft) | LNAPL Thickness (ft) |
|---|---|---|---|---|
| MW-1 | Initial Reading 8/19/96 | 17.96 | 15.50 | 2.46 |
| | 8/19/96-1414 | 17.13 | 17.08 | 0.050 |
| | 8/19/96-1417 | 17.04 | 16.93 | 0.11 |
| | 8/19/96-1421 | 17.00 | 16.85 | 0.15 |
| | 8/19/96-1428 | 16.98 | 16.82 | 0.16 |
| | 8/19/96-1434 | 16.89 | 16.79 | 0.10 |
| MW-3 | Initial Reading 8/19/96 | 19.50 | 14.75 | 4.75 |
| | 8/19/96-1347 | 17.18 | 17.14 | 0.040 |
| | 8/19/96-1349 | 16.79 | 16.71 | 0.080 |
| | 8/19/96-1352 | 16.48 | 16.35 | 0.13 |
| | 8/19/96-1356 | 16.36 | 16.20 | 0.16 |
| | 8/19/96-1400 | 16.32 | 16.10 | 0.22 |
| | 8/19/96-1405 | 16.32 | 16.04 | 0.28 |
| | 8/19/96-1438 | 16.42 | 15.93 | 0.49 |
| MW-7 | Initial Reading 8/19/96 | 19.58 | 12.81 | 6.77 |
| | 8/19/96-1308 | 17.21 | 16.90 | 0.31 |
| | 8/19/96-1310 | 17.10 | 16.65 | 0.45 |
| | 8/19/96-1312 | 17.05 | 16.44 | 0.61 |
| | 8/19/96-1314 | 17.00 | 16.27 | 0.73 |
| | 8/19/96-1316 | 16.97 | 16.10 | 0.87 |
| | 8/19/96-1320 | 16.93 | 15.92 | 1.01 |
| | 8/19/96-1323 | 16.90 | 15.78 | 1.12 |

Table 2. Results of Baildown Testing, Griffiss AFB, NY (continued)

| Monitoring Well | Sample Collection Time | Depth to Groundwater (ft) | Depth to LNAPL (ft) | LNAPL Thickness (ft) |
|---|---|---|---|---|
| MW-7 (cont'd) | 8/19/96-1330 | 16.83 | 15.50 | 1.33 |
| | 8/19/96-1335 | 16.78 | 15.33 | 1.45 |
| | 8/19/96-1345 | 16.70 | 15.15 | 1.55 |
| | 8/19/96-1408 | 16.54 | 14.90 | 1.64 |
| | 8/19/96-1436 | 16.52 | 14.82 | 1.70 |
| | 8/20/96-0825 | 17.57 | 15.09 | 2.48 |
| | 8/20/96-0846 | 18.94 | 16.39 | 2.55 |
| MW-8 | Initial Reading 8/19/96 | 20.42 | 19.31 | 1.11 |
| | 8/19/96-1441 | 19.20 | 19.11 | 0.090 |
| | 8/19/96-1445 | 18.93 | 18.65 | 0.28 |
| | 8/19/96-1451 | 19.05 | 18.53 | 0.52 |
| | 8/19/96-1456 | 19.12 | 18.50 | 0.62 |
| | 8/19/96-1503 | 19.17 | 18.52 | 0.65 |
| | 8/19/96-1516 | 19.20 | 18.49 | 0.71 |

## 4.2 Soil Sample Analyses

Table 3 shows the TPH and BTEX concentrations measured in soil samples collected from Pump House 5. TPH and BTEX concentrations were very similar between the two samples, with an average TPH concentration of 4,700 mg/kg and an average BTEX concentration of 105 mg/kg. The results of the physical characterization and inorganic analysis of the soil are presented in Table 4. Soils were very permeable, with soils primarily falling into the granule soil size classification.

## 4.3 LNAPL Pump Test Results

### 4.3.1 Initial Skimmer Pump Test Results

No significant quantities of LNAPL were recovered during this test during 45 hr of continuous extraction (Table 5). A total of 255 gallons of groundwater was extracted with an average extraction rate of 136 gallons/day (Table 5). Results of LNAPL recovery versus time are shown in Figure 8.

### 4.3.2 Bioslurper Pump Test Results

#### 4.3.2.1 Monitoring Well MW-7

LNAPL recovery was possible during the bioslurper pump test although recovery rates were low (Figure 8). Bioslurper testing was conducted for two days resulting in relatively low recovery on the first day (1.2 gallons/day) followed by no measurable product recovery on the second day. A total of 1.2 gallons of LNAPL and 2,075 gallons of groundwater was extracted, with daily average recovery rates of 0.60 gallons/day for LNAPL and 1,307 gallons/day for groundwater (Table 5). The LNAPL recovery rate versus time is shown in Figure 9. The vacuum-exerted wellhead pressure on monitoring well MW-7 was high throughout the bioslurper pump test at approximately 23 inches of Hg.

Soil gas concentrations were measured during the bioslurper test at monitoring points adjacent to monitoring well MW-7 to determine if the vadose zone was being oxygenated via the bioslurper action. Oxygen concentrations were most influenced at monitoring point MP1, 10 ft from the bioslurper well (Table 6). Based on the soil gas permeability test, where a radius of influence of 38

**Table 3. TPH and BTEX Concentrations in Soil Samples from Griffiss AFB, NY**

| Parameter | Concentration (mg/kg) | |
|---|---|---|
| | GRF-A1 | GRF-A2 |
| TPH (purgeable) | 4,700 | 4,700 |
| Benzene | <1.0 | <1.0 |
| Toluene | <1.0 | <1.0 |
| Ethylbenzene | 23 | 21 |
| Xylenes | 82 | 82 |

**Table 4. Physical Characterization of Soils from Griffiss AFB, NY**

| Parameter | Sample | |
|---|---|---|
| | GRF-A1 | GRF-A2 |
| Moisture Content (%) | 14.0 | 14.0 |
| Density (g/cm$^3$) | 1.42 | 1.46 |
| Porosity (%) | 46.4 | 44.9 |
| **Sieve Analysis** | | |
| **Particle Size (mm)** | **Percent** | |
| 254 | 0 | |
| 16 | 20 | |
| 2.38 | 79.4 | |
| 2.00 | 0.6 | |
| 1.19 | <0.10 | |
| 0.59 | <0.10 | |
| 0.42 | <0.10 | |
| 0.30 | <0.10 | |

Table 5. Pump Test Results at Monitoring Well MW-7, Griffiss AFB, NY

| Time (days) | Recovery Rate (gal/day) | | | | | |
|---|---|---|---|---|---|---|
| | Skimmer Pump Test | | Bioslurper Pump Test | | Drawdown Pump Test | |
| | LNAPL | Groundwater | LNAPL | Groundwater | LNAPL | Groundwater |
| 1 | 0 | 171 | 1.2 | 1,518 | 0 | 318 |
| 2 | Sheen | 105 | Sheen | 1,095 | 0 | 255 |
| Average (gal/day) | 0 | 136 | 0.60 | 1,307 | 0 | 285 |
| Total Recovery (gal) | 0 | 255 | 1.2 | 2,075 | 0 | 541 |

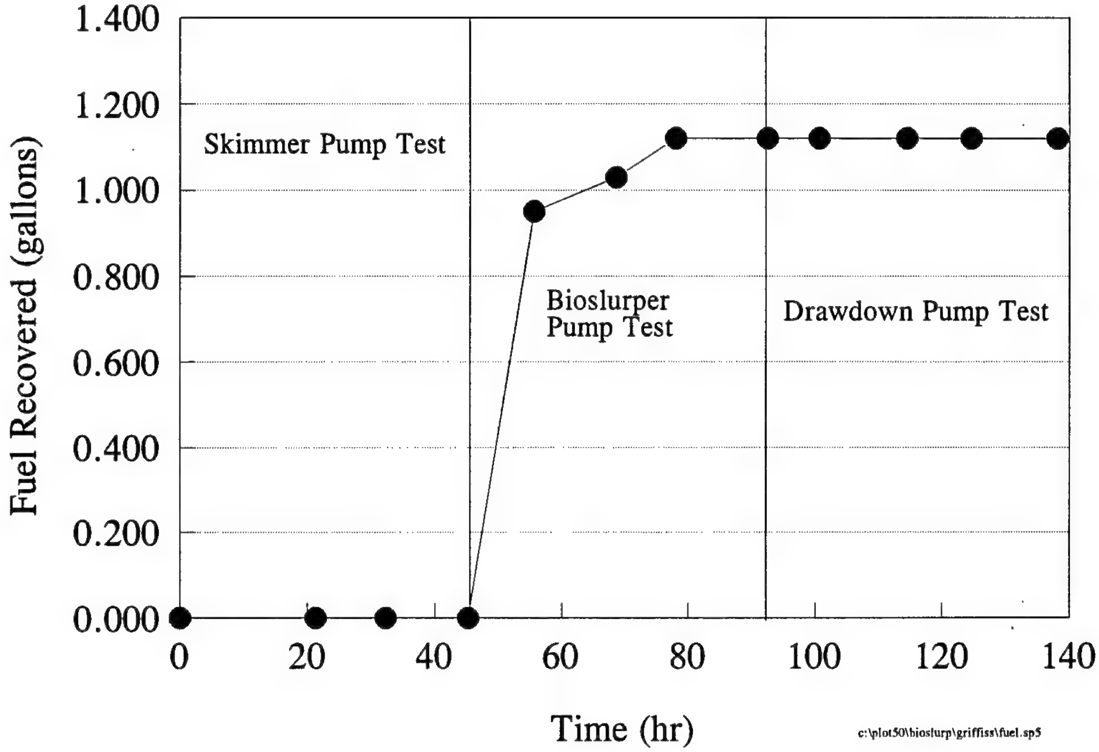


**Figure 8. Fuel Recovery Versus Time During Each Pump Test in Monitoring Well MW-7**

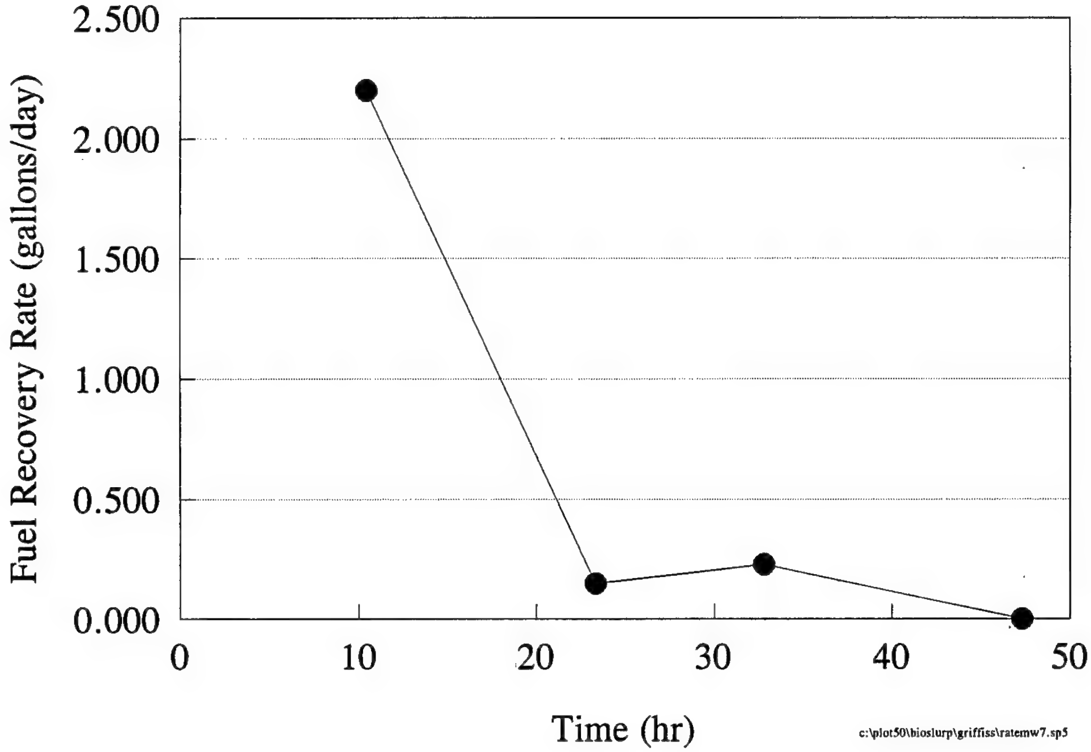


**Figure 9. LNAPL Recovery Rate Versus Time During the Bioslurper Pump Test at Monitoring Well MW-7**

**Table 6. Oxygen Concentrations During the Bioslurper Pump Test at MW-7, Griffiss AFB, NY**

| Monitoring Point | Depth (ft) | Oxygen Concentrations (%) Versus Time (hours) | | | |
|---|---|---|---|---|---|
| | | 0 | 56.6 | 69.4 | 79.6 |
| MP1 | 6.0 | 0 | 9.0 | 16.5 | 18 |
| | 8.0 | 0 | 5.0 | 2.0 | 1.5 |
| | 10.0 | 2.0 | 5.0 | 1.5 | 0 |
| MP2 | 4.0 | 0 | 4.0 | 0 | 4.5 |
| | 6.0 | 0 | 2.0 | 1.0 | 0 |
| | 8.0 | 0 | 1.0 | 1.0 | 0 |
| MP3 | 6.0 | 0 | 0 | 1.0 | 0 |
| | 8.0 | 0 | 0 | 0 | 0 |
| | 10.0 | 0 | 0 | 1.0 | 0 |

ft was measured, it is likely that these areas will become fully aerated. In short, a two day extraction time frame at 6 scfm is insufficient to exchange sufficient pore volumes of soil gas to fully oxygenate the zone of influence.

#### 4.3.2.2 Monitoring Well MW-3

In an effort to determine if the results at monitoring well MW-7 were representative of site conditions, bioslurper testing was conducted at monitoring well MW-3. Minimal free-phase LNAPL was recovered on the first day of bioslurper pumping (1.65 gallons/day) (Table 7). No measurable LNAPL free product was recovered on the second day of continuous extraction. The LNAPL recovery rate versus time is shown in Figure 10. The well head vacuum on monitoring well MW-3 (7 inches Hg) and groundwater production rate (1,100 gallons/day) were similar to those observed at monitoring well MW-7. Results at monitoring wells MW-7 and MW-3 appear to be representative of the site and indicate that gravity-driven or even vacuum-enhanced liquid recovery techniques are not feasible.

**Table 7. Bioslurper Pump Test Results at Monitoring Well MW-3, Griffis AFB, NY**

| Time (days) | Recovery Rate (gallons/day) | |
|---|---|---|
| | LNAPL | Groundwater |
| 1 | 1.66 | 1,171 |
| 2 | 0 | 1,135 |
| Average (gal/day) | 0.82 | 1,153 |
| Total (gal) | 1.61 | 2,257 |

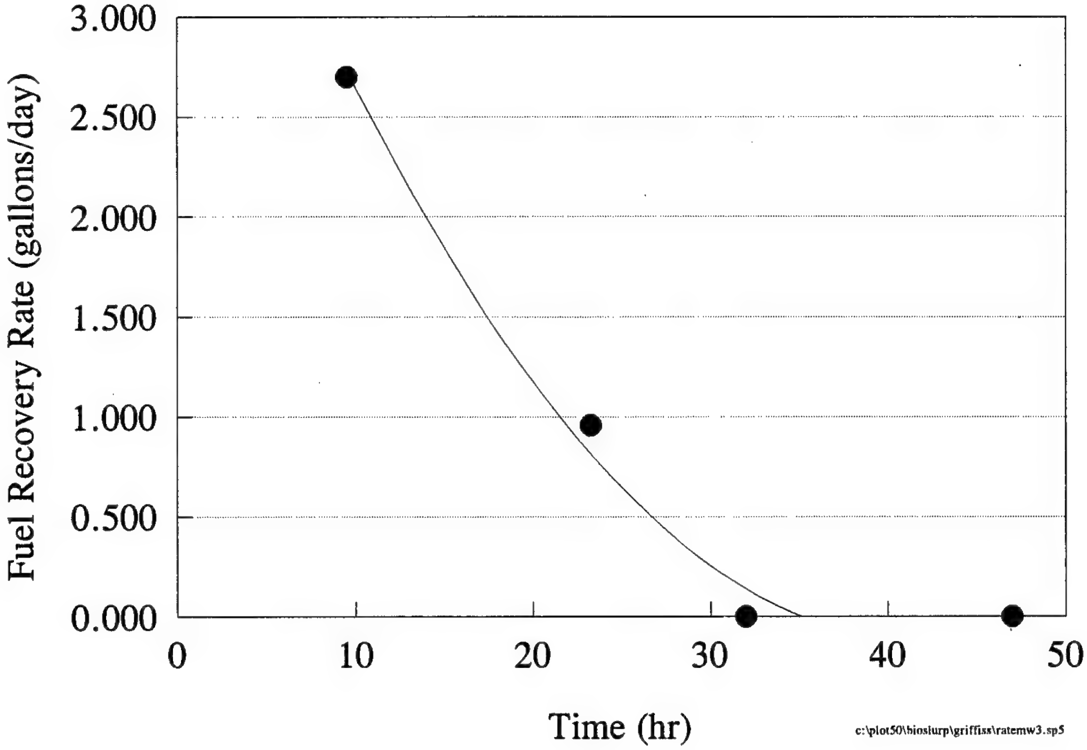


**Figure 10. LNAPL Recovery Rate Versus Time During the Bioslurper Pump Test at Monitoring Well MW-3**

### 4.3.3 Drawdown Pump Test

Drawdown pump testing was conducted to determine if a cone of groundwater depression would enhance LNAPL recovery. The water table was depressed 1.5 ft below the static water table in monitoring well MW-7. No measurable LNAPL free product was recovered in this mode during two days of continuous extraction (Table 5). Groundwater recovery rates were on the order of 300 gallons/day. As stated above, the vacuum gradient maintained during the bioslurper test resulted in higher fluid recovery rates than the 1.5 ft groundwater drawdown test.

### 4.3.4 Extracted Groundwater, LNAPL, and Off-Gas Analyses

Results of groundwater analyses are shown in Table 8. Contaminant concentrations were similar between the two samples, with average TPH and total BTEX concentrations of 3.2 mg/L and 1.1 mg/L, respectively. The on-site water treatment equipment, consisting of a filter tank, oil/water separator, and clarification tanks, resulted in water effluent (2.8 to 3.5 mg/L total hydrocarbons) that is considered compatible with typical sanitary sewer discharge limits.

The results from the off-gas analyses are presented in Table 9. Given a vapor discharge rate of 6 scfm and using an average concentration of 36,500 ppmv TPH and 115 ppmv benzene, approximately 91 lb/day of TPH and 0.20 lb/day of benzene were emitted to the air. Thus, initially, mass removal in the vapor phase is significant. However, this short-term test does not provide a good indication as to whether these rates would be sustained. Higher vapor mass removal rates are more often sustained at those sites where liquid product recovery is sustained.

Analyses for chlorinated compounds in the off-gas were conducted; however, no chlorinated compounds were detected. 1,3,5-Trimethylbenzene and 1,2,4-trimethylbenzene were detected at average concentrations of 36 and 90 ppmv, respectively.

The composition of LNAPL is shown in Table 10 and 11 in terms of BTEX concentrations and distribution of C-range compounds, respectively. The distribution of C-range compounds also is shown graphically in Figure 11.

**Table 8.** **TPH and BTEX Concentrations in Extracted Groundwater During the Bioslurper Pump Test at Monitoring Well MW-7, Griffiss AFB, NY**

| Parameter | Concentration (mg/L) | |
|---|---|---|
| | GFSDW1 | GFSDW2 |
| TPH (purgeable) | 3.5 | 2.8 |
| Benzene | 0.40 | 0.22 |
| Toluene | 0.026 | 0.027 |
| Ethylbenzene | 0.18 | 0.11 |
| Xylenes | 0.84 | 0.44 |

**Table 9.** **BTEX and TPH Concentrations in Off-Gas During the Bioslurper Pump Test at Monitoring Well MW-7, Griffiss AFB, NY**

| Parameter | Concentration (ppmv) | |
|---|---|---|
| | GRF-OGS-1 | GRF-OGS-2 |
| TPH as jet fuel | 38,000 | 35,000 |
| Benzene | 130 | 100 |
| Toluene | <24 | <21 |
| Ethylbenzene | 61 | 57 |
| Xylenes | 240 | 220 |
| 1,3,5-Trimethylbenzene | 35 | 36 |
| 1,2,4-Trimethylbenzene | 99 | 80 |
| Hexane | 8,000 | 7,000 |
| Heptane | 2,100 | 2,000 |

**Table 10. BTEX Concentrations in LNAPL from Griffiss AFB, NY**

| Compound | Concentrations (mg/kg) |
|---|---|
| Benzene | 1.3 |
| Toluene | 0.2 |
| Ethylbenzene | 3.8 |
| Total Xylenes | 18.0 |

**Table 11. C-Range Compounds in LNAPL from Griffiss AFB, NY**

| C-Range Compound | Percentage of Total |
|---|---|
| <C8 | 44.40 |
| C9 | 9.60 |
| C10 | 11.01 |
| C11 | 12.26 |
| C12 | 11.34 |
| C13 | 7.25 |
| C14 | 2.52 |
| C15 | 0.71 |
| C16 | 0.27 |
| >C17 | 0.63 |

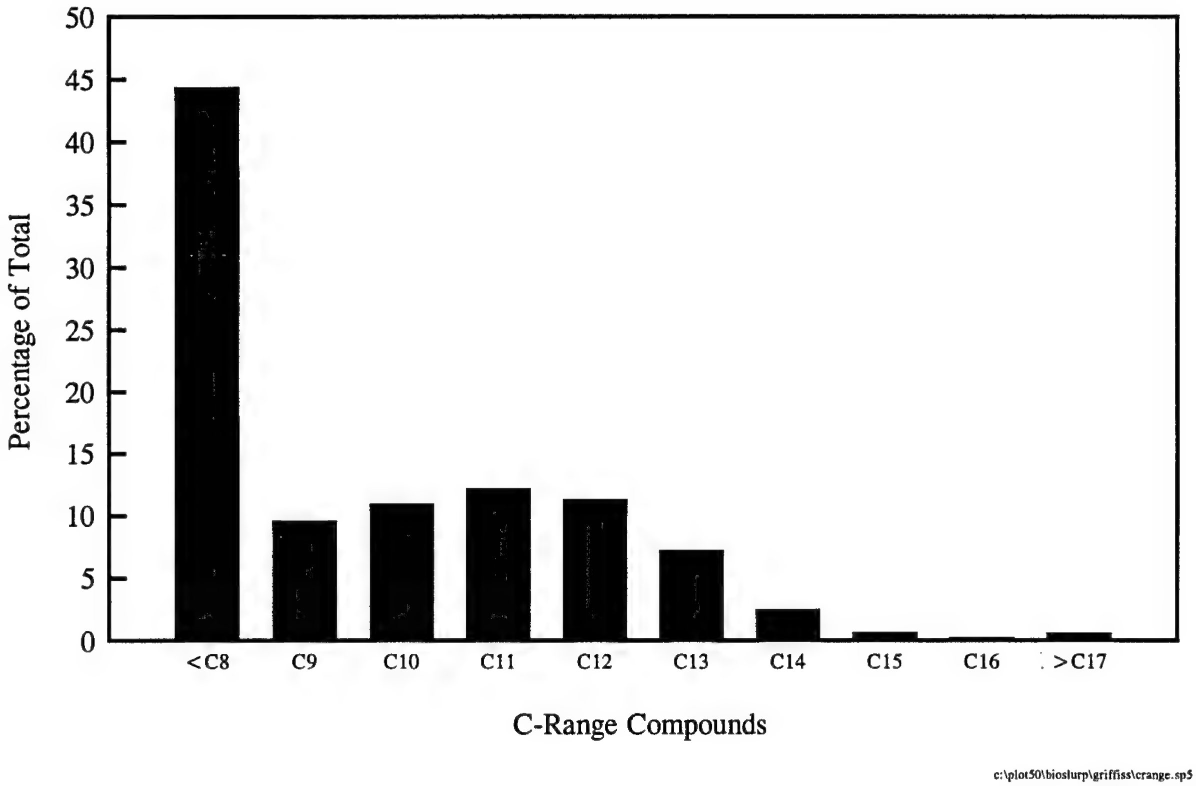


**Figure 11. Distribution of C-Range Compounds in Extracted LNAPL at Griffis AFB, NY**

## 4.4 Bioventing Analyses

### 4.4.1 Soil Gas Permeability and Radius of Influence

The radius of influence is calculated by plotting the log of the pressure change at a specific monitoring point versus the distance from the extraction well. The radius of influence is then defined as the distance from the extraction well where 0.10 inch of $H_2O$ can be measured. Based on this definition, the radius of influence during the bioslurper pump test at monitoring well MW-7 was approximately 38 ft (Figure 12).

### 4.4.2 In Situ Respiration Test Results

Results from the in situ respiration test are presented in Table 12. Oxygen utilization rates were relatively high, ranging from 0.35 to 0.69 $\%O_2$/hr. Biodegradation rates ranged from 5.8 to 11 mg/kg-day. These results indicate that biodegradation in these locations is significant and that bioventing is feasible at this site.

**Table 12. In Situ Respiration Test Results at Griffiss AFB, NY**

| Monitoring Point | Oxygen Utilization Rate (%/hr) | Biodegradation Rate (mg/kg-day) |
|---|---|---|
| MP1-10.0′ | 0.69 | 11 |
| MP2-8.0′ | 0.37 | 6.2 |
| MP3-10.0′ | 0.35 | 5.8 |

## 5.0 DISCUSSION AND CONCLUSIONS

The main objective of the field pilot test at Pump House 5, Griffiss AFB was to determine if LNAPL recovery is feasible and to select the most effective method of LNAPL recovery.

Baildown recovery tests were conducted at monitoring wells MW-1, MW-3, MW-7, and MW-8. Baildown recovery tests provide a qualitative indication of the presence of mobile, free-phase

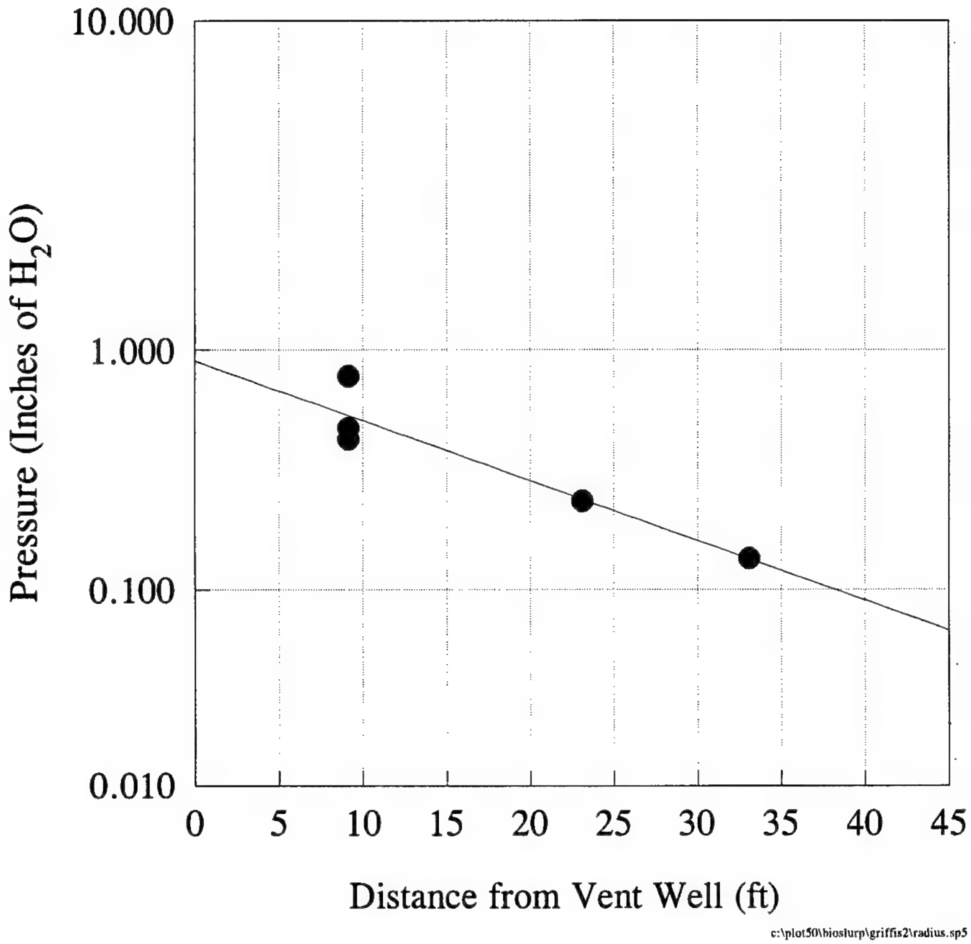


**Figure 12. Soil Gas Pressure Change as a Function of Distance During the Soil Gas Permeability Test at Monitoring Well MW-7**

LNAPL and recovery potential. Overall the baildown recovery tests indicated a relatively slow rate of LNAPL recovery into the wells. Also, short-term baildown recovery resulted in LNAPL thicknesses substantially less than initial apparent thicknesses. Monitoring well MW-8 recovered to an LNAPL thickness of 0.71 ft which is closer to the initial apparent thickness (1.11 ft). Monitoring well MW-7 had the highest initial apparent thickness (6.77 ft) and the highest rate of initial recovery. Based on these results, pilot testing was initiated on monitoring well MW-7.

Direct pumping tests were conducted at monitoring wells MW-7 and MW-3. Skimmer pump testing was conducted at monitoring well MW-7 in a continuous extraction mode for two days. No measurable free-phase LNAPL was recovered during the two days of skimmer pump testing, indicating that gravity-driven recovery is minimal. Bioslurper testing was conducted for two days resulting in relatively low recovery on the first day (1.2 gal/day) followed by no measurable product recovery on the second day. Vacuum levels in the well were high at 23 inches Hg. Groundwater production rates during bioslurping were higher than rates during the drawdown pump test, indicating that vacuum enhanced fluid recovery was in effect during the bioslurper test. The on-site water treatment equipment, consisting of a filter tank, oil/water separator, and clarification tanks, resulted in water effluent (2.8 to 3.5 mg/L total hydrocarbons) that is considered compatible with typical sanitary sewer discharge limits.

In an effort to determine if the results at monitoring well MW-7 were representative of site conditions, bioslurper testing was conducted at monitoring well MW-3. Minimal free-phase LNAPL was recovered on the first day of bioslurper pumping (1.65 gallons/day). No measurable LNAPL free product was recovered on the second day of continuous extraction. The well head vacuum on monitoring well MW-3 (7 inches Hg) and groundwater production rate (1,100 gallons/day) were similar to those observed at monitoring well MW-7. Results at monitoring wells MW-7 and MW-3 appear to be representative of the site and indicate that gravity-driven or even vacuum-enhanced liquid recovery techniques are not feasible.

Drawdown testing was conducted to determine if a cone of groundwater depression would enhance LNAPL recovery. The water table was depressed in monitoring well MW-7 1.5 ft below the static water table. No measurable LNAPL free product was recovered in this mode during two days of continuous extraction. Groundwater recovery rates were on the order of 300 gallons/day. As stated above, the vacuum gradient maintained during the bioslurper test resulted in higher fluid recovery rates than the 1.5 ft groundwater drawdown test.

Bioslurping also promotes mass removal in the form of in situ biodegradation via bioventing and soil gas extraction. Vapor phase mass removal is the result of soil gas extraction as well as volatilization that occurs during the movement of LNAPL free product through the extraction network. Given, the measured vapor flowrate (6 scfm) and vapor concentrations, initial hydrocarbon removal rates were approximately 91 lb/day of TPH and 0.20 lb/day of benzene. Thus, initially, mass removal in the vapor phase is significant. However, this short-term test does not provide a good indication as to whether these rates would be sustained. Higher vapor mass removal rates are more often sustained at those sites where liquid product recovery is sustained.

The initial soil gas profiles at the site displayed oxygen-deficient, carbon dioxide-rich, high total volatile hydrocarbon vapor conditions across the 4 to 10 ft below ground surface horizons. These conditions indicate that natural biodegradation of residual petroleum hydrocarbons has occurred, but is limited by oxygen availability. Soil gas concentrations were measured during the bioslurper test at monitoring points adjacent to monitoring well MW-7 to determine if the vadose zone was being oxygenated via the bioslurper action. Oxygen concentrations were most influenced at monitoring point MP1, 10 ft from the bioslurper well. Based on the soil gas permeability test, where a radius of influence of 38 ft was measured, it is likely that these areas will become fully aerated. In short, a two day extraction time frame at 6 scfm is insufficient to exchange sufficient pore volumes of soil gas to fully oxygenate the zone of influence. In situ biodegradation rates of 5.8 to 11 mg/kg-day were measured at three different locations. Based on the radius of influence of 38 ft and a hydrocarbon-impacted soil thickness of 18 ft, mass removal rates via biodegradation are on the order of 43 to 81 lbs of hydrocarbon per day. Thus, mass removal rates via biodegradation could be as significant as the initial vapor phase removal rates measured during the bioslurper test. These results indicate that bioventing is feasible at this site. Air injection bioventing is preferable over bioslurping and soil vapor extraction with respect to the elimination of hydrocarbon vapor emissions.

In summary, the on-site testing at Pump House 5, Griffiss AFB, included the direct testing of gravity-driven and vacuum-driven LNAPL free product recovery techniques, bioventing, physical sampling, and tests relevant to soil vapor extraction. Liquid phase recovery was not sustainable in any of the extraction modes. The vacuum-enhanced mode is significant in that if liquid phase LNAPL recovery is not sustainable under high vacuum conditions, then it is unlikely that it will be sustainable under any conditions. Vapor phase mass removal rates measured during bioslurper testing may be the result of soil gas removal (i.e. SVE) or volatilization during liquid entrainment. The generation of off-gas is undesirable and sustained rates of off-gas discharge cannot be estimated

accurately from this test. The in situ respiration test and vadose zone radius of influence testing demonstrate that bioventing is feasible at this site.

Periodic baildown recovery tests are recommended as a useful indicator of LNAPL free product recovery potential. Based on the conduct of identical pilot tests at over 25 different sites, there have been several sites where apparent LNAPL product thicknesses are significant (>3 ft). However, once the LNAPL free product is removed from the well, it may take weeks or months to return to initial apparent thicknesses. LNAPL free product continues to accumulate in monitoring wells, but not at a rate to make free product recovery worthwhile. The periodic baildown recovery test is the best method to verify whether or not the Pump House 5 site is like the sites described above. Periodic hand bailing may also represent removing LNAPL free product to the extent practicable.

This pilot test effort is a logical follow-on to the AFCEE/ERT intrinsic remediation investigation conducted at Pump House #5. The "Intrinsic Remediation Report" recommended the consideration of source removal, and this free product recovery pilot test was designed to determine the feasibility of some of the most effective technologies and select the best method of source removal. Further consideration should be given to an overall risk management strategy to include natural attenuation, and the evaluation of soil vapor extraction via internal combustion engine (ICE) (AFCEE/ERT ICE Report, 1994), bioventing, and periodic baildown recovery tests.

## 6.0 REFERENCES

Battelle, 1995. *Test Plan and Technical Protocol for Bioslurping.* Report prepared by Battelle Columbus Operations for the U.S. Air Force Center for Environmental Excellence, Brooks Air Force Base, Texas.

Hinchee, R.E., S.K. Ong, R.N. Miller, D.C. Downey, and R. Frandt. 1992. *Test Plan and Technical Protocol for a Field Treatability Test for Bioventing* (Rev. 2). Report prepared by Battelle Columbus Operations, U.S. Air Force Center for Environmental Excellence, and Engineering Sciences, Inc., for the U.S. Air Force Center for Environmental Excellence, Brooks Air Force Base, Texas.

# APPENDIX A

# SITE-SPECIFIC TEST PLAN FOR BIOSLURPER FIELD ACTIVITIES AT GRIFFISS AFB, NEW YORK

# SITE-SPECIFIC TEST PLAN FOR BIOSLURPER TESTING AT THE PUMPHOUSE 5 SITE, GRIFFISS AIR FORCE BASE, NEW YORK

**DRAFT**

**PREPARED FOR:**

**AIR FORCE CENTER FOR ENVIRONMENTAL EXCELLENCE**
**TECHNOLOGY TRANSFER DIVISION**
**(AFCEE/ERT)**
**8001 ARNOLD DRIVE**
**BROOKS AFB, TEXAS 78235-5357**

**AND**

**305 SPTG/CEV**
**GRIFFISS AFB, NEW YORK**

**4 DECEMBER 1995**

# SITE-SPECIFIC TEST PLAN FOR BIOSLURPER TESTING AT THE PUMPHOUSE 5 SITE, GRIFFISS AIR FORCE BASE, NEW YORK (A002) CONTRACT NO. F41624-94-C-8012

**DRAFT**

**to**

**Air Force Center for Environmental Excellence**
**Technology Transfer Division**
**(AFCEE/ERT)**
**8001 Arnold Drive**
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**and**

**305 SPTG/CEV**
**Griffiss Air Force Base, New York**

**December 4, 1995**

**by**

**Battelle**
**505 King Avenue**
**Columbus, Ohio 43201-2693**

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# SITE-SPECIFIC TEST PLAN FOR BIOSLURPER TESTING AT THE PUMPHOUSE 5 SITE, GRIFFISS AIR FORCE BASE, NEW YORK

**DRAFT**

**to**

**Air Force Center for Environmental Excellence**
**Technology Transfer Division**
**(AFCEE/ERT)**
**Brooks AFB, Texas 78235-5357**

**December 4, 1995**

## 1.0 INTRODUCTION

The U.S. Air Force Center for Environmental Excellence (AFCEE) Technology Transfer Division is conducting a nationwide application of an innovative technology for free-product recovery and soil bioremediation. The technologies tested in the Bioslurper Initiative include vacuum-enhanced free-product recovery/bioremediation (bioslurping) as well as traditional skimmer and groundwater depression approaches. The field test and evaluation are intended to demonstrate the feasibility of free-product recovery by measuring system performance in the field. System performance parameters, mainly free-product recovery, will be determined at numerous sites. Field testing will be performed at many sites to determine the effects of different organic contaminant types and concentrations and different geologic conditions on bioslurping effectiveness.

Plans for the field test activities are presented in two documents. The first is the overall Test Plan and Technical Protocol for the entire program entitled *Test Plan and Technical Protocol for Bioslurping* (Battelle, 1995). The overall plan is supplemented by plans specific to each test site. The concise site-specific plans effectively communicate planned site activities and operational parameters.

The overall Test Plan and Technical Protocol was developed as a generic plan for the Bioslurper Initiative to improve the accuracy and efficiency of site-specific Test Plan preparation. The field program involves installation and operation of the bioslurping system supported by a wide variety of site characterization, performance monitoring, and chemical analysis activities. The basic methods to be applied from site to site do not change. Preparation and review of the overall Test Plan and Technical Protocol allows efficient documentation and review of the basic approach to the test program.

This report is the site-specific Test Plan for application of bioslurping at Griffiss Air Force Base (AFB), New York. It was prepared based on site-specific information received by Battelle from Griffiss AFB and other pertinent site-specific information to support the overall Test Plan and Technical Protocol.

## 2.0 SITE DESCRIPTION

The site description information presented in this section was obtained from the *Work Plan for a Treatability Study in Support of the Intrinsic Remediation (Natural Attenuation) Option at Pumphouse 5 (Building 771)* prepared for the AFCEE and Griffiss AFB by Parsons Engineering Science, Inc., June 1995. Additional information was obtained from *Building 771 (Pumphouse 5) Engineering Evaluation/Cost Analysis Report* dated February 1995.

Griffiss AFB is located in central New York State and is bordered on the west by the city of Rome (Figure 1). The base is surrounded by land used for agricultural, residential, commercial, and industrial purposes. The 3,900 contiguous acres are located in the Mohawk River Valley.

The base has been in operation since February 1942, with the primary mission of maintaining and implementing effective aerial refueling operations and providing bombardment capabilities. Pumphouse 5 (Building 771), the area identified as a source Area of Concern (AOC), serves as a fuel storage and transfer station for aircraft refueling operations.

Located in the vicinity of Pumphouse 5 are four 50,000-gallon underground storage tanks (USTs) containing JP-4 jet fuel, of which an unknown number are found below the water table. Northwest of Pumphouse 5 are two valve pits and a 2,000-gallon collection tank. Pumphouse 5 is part of the base fuel distribution system (Figures 2 and 3). A drainage ditch located 250 ft north of the pumphouse is a potential receptor of groundwater discharge.

There are records of three large spills known to have contributed to contamination at the site. Fuel released from an aircraft fire in 1977 was the cause of a Class III JP-4 spill. Griffiss AFB personnel indicate that the fuel was discharged off site due to an open trench gate in the center of the apron. An occurrence reported in 1989 was the result of indications of free-phase fuel product found in samples from monitoring wells at Pumphouse 5. A Class III JP-4 spill again occurred in 1991 between the fillstand and Pumphouse 5. Sorbent material was used to clean up the spill.

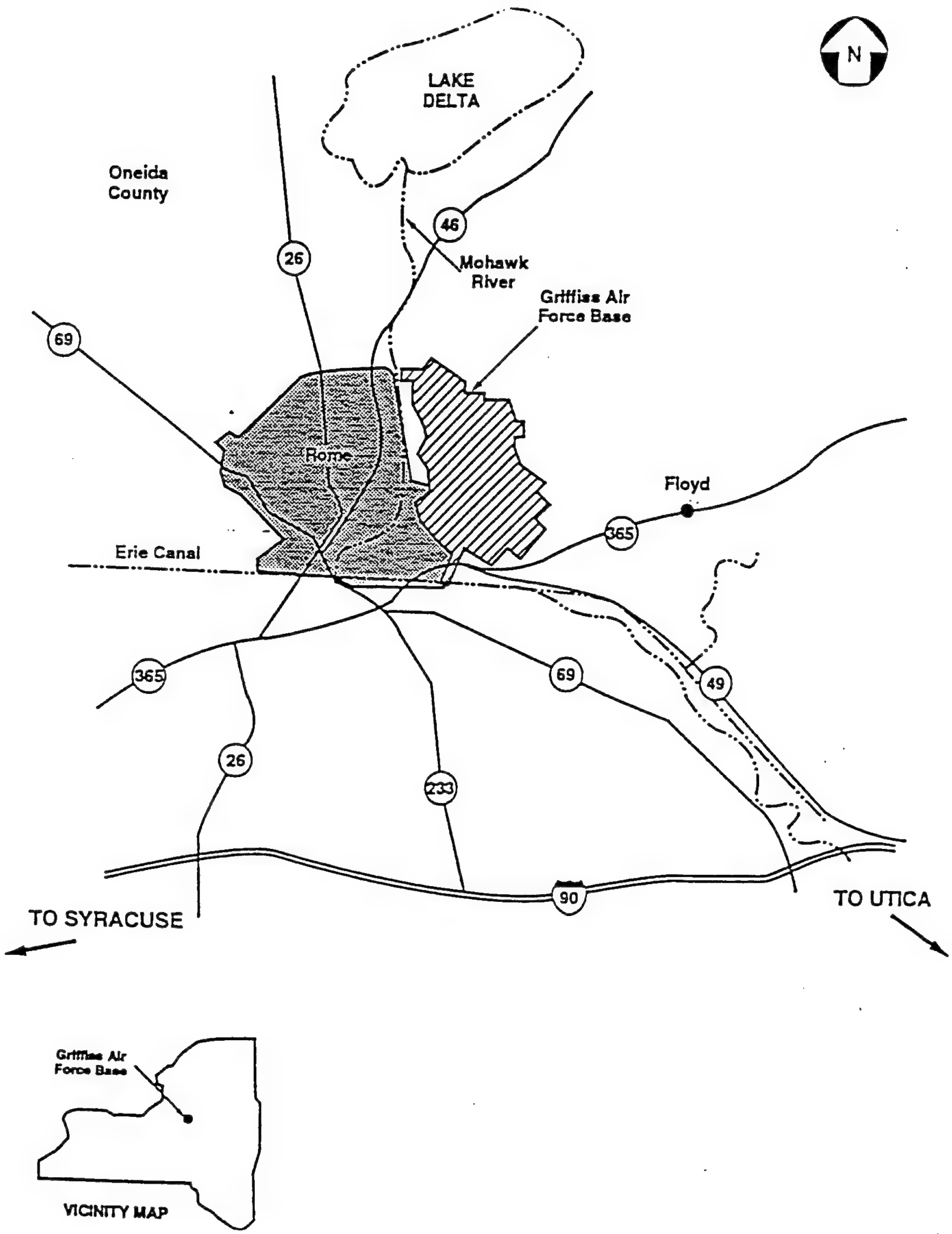


**Figure 1.** **Location of Griffiss AFB, NY**
**(Source: Parsons Engineering Science, Inc., 1995a)**

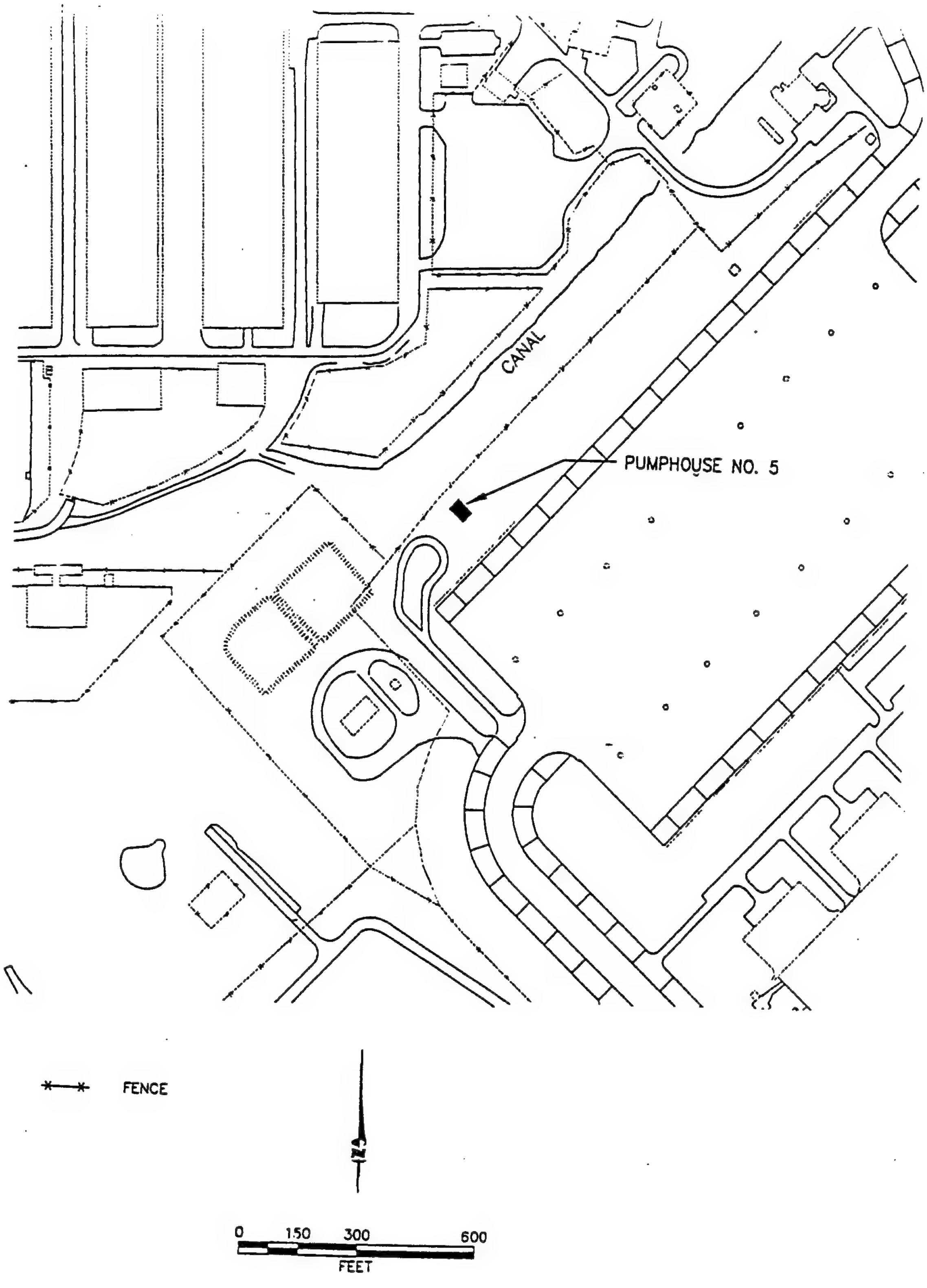


**Figure 2.** **Location of Pumphouse 5 at Griffiss AFB (Source: Parsons Engineering Science, Inc., 1995a)**

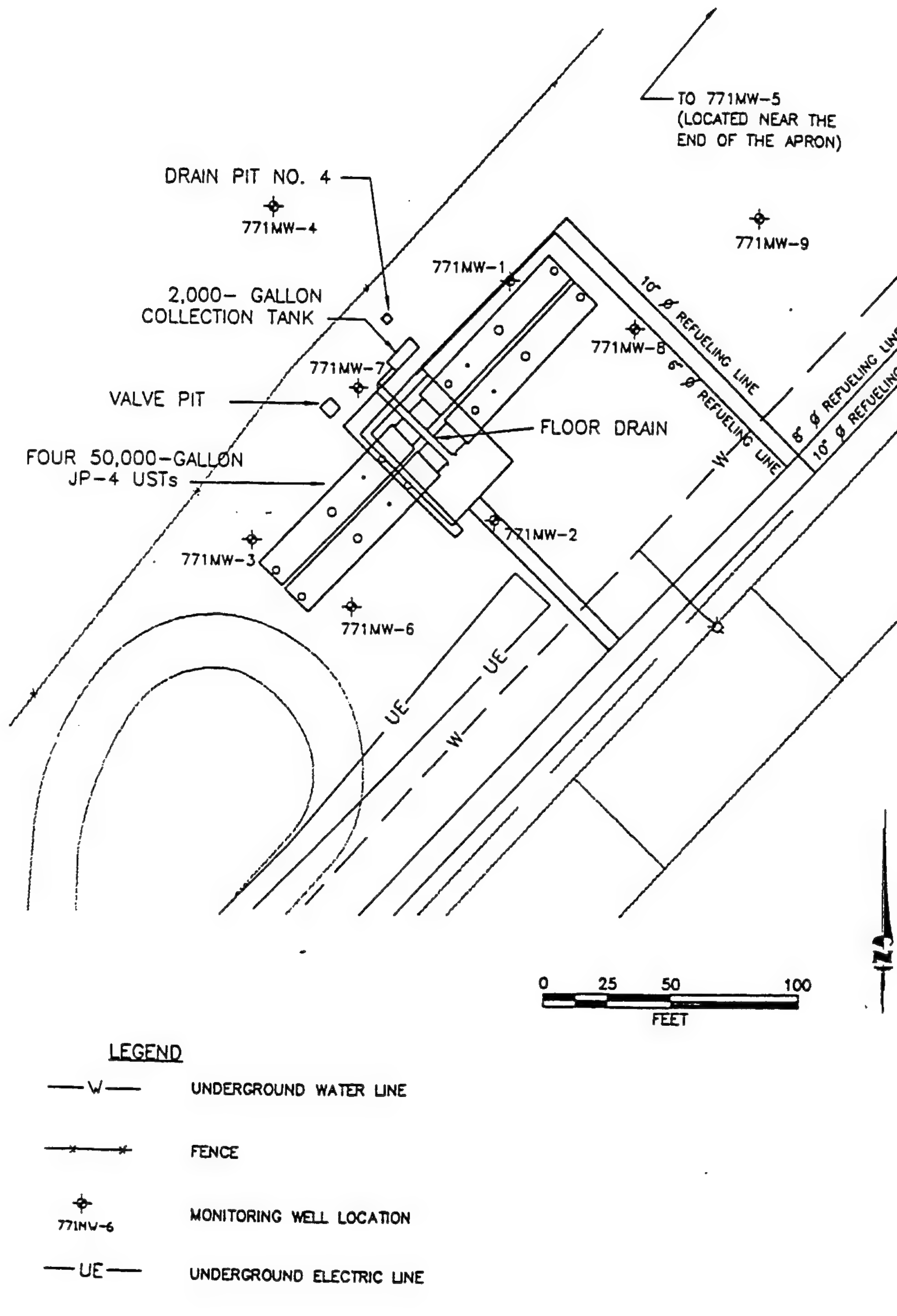


Figure 3. Pumphouse 5 Site Map, Griffiss AFB
(Source: Parsons Engineering Science, Inc., 1995a)

Attempts have been made to define the limits of contamination through leak detection investigations and a soil gas survey. Three monitoring wells were installed in 1989, and an additional seven wells were installed in 1991. In each of the wells where free product was observed, a flexible axial peristaltic (FAP) pump petroleum-skimming system was used to draw down free product. This operation was begun in early 1993 and, in conjunction with hand bailing, removed 25 to 50 gallons of free product in 6 months. Since this time, several other incidences have contributed to further contamination. Personnel report that the 2,000-gallon fuel collection tank has been overfilled on occasions in the past. Furthermore, a leak attributed to a broken fitting in the pipe connecting the collection tank to the pumphouse floor drain was discovered in 1994.

## 2.1 Site Geology

Griffiss AFB and its vicinity rest on hundreds of feet of shale bedrock covered by unconsolidated materials of coarser texture described as gray sandy shale. From south to north, the area tends to demonstrate a coarsening of sediments and a decreasing depth to bedrock.

Site soils consist of silty sands underlain by glacial till in the east- and west-central areas with the remainder of the site consisting of gravels. The southern portion is underlain by well-sorted sands.

Pumphouse 5 (Building 771) is described as having fine- to medium-grained sand, gravel, and traces of clay. These sands tend to dominate both the vadose and saturated zones with the exception of clayey soils observed at 12 to 19 ft below ground surface (bgs) at several boreholes. Depth to bedrock ranges from 25 to 50 ft bgs at the site area. A summary of soil characteristics at monitoring wells 771MW-4 through 771MW-9 can be seen in Table 1.

## 2.2 Aquifer Characteristics

Groundwater is generally found between 14 and 19 ft bgs across the site and at shallower depths in adjacent areas (Table 2). Flow tends to be counter-regional to the southwesterly groundwater flow pattern of the base. The northern portion of the site experiences north and northwest flow throughout the year with possible discharge into a drainage ditch located 250 ft northwest of the pumphouse. The flow direction to the south of the pumphouse is predominantly north; however, some localized flow patterns develop specific to the seasons. Flow direction to the east of the pumphouse tends to be erratic.

The average hydraulic gradient across the site has been estimated at 0.060 ft/ft. Both rising- and falling-head slug test data were used to measure hydraulic conductivity. These values were found to be $3.03 \times 10^{-4}$ ft/min and $2.19 \times 10^{-3}$ ft/min respectively. Using these data and an assumed porosity of 30%, the groundwater velocity at the site is estimated to be $4.38 \times 10^{-4}$ ft/min or 0.63 ft/day.

## 2.3 Site Contamination

Site contamination in the form of JP-4 was first detected in 1989 by the appearance of free product in the monitoring wells. Light, nonaqueous-phase liquid (LNAPL) levels, which continued to be monitored until 1995, ranged from 0.01 to 5.07 ft (Table 3). Samples from a soil gas survey performed at the end of 1989 were analyzed for benzene, toluene, ethylbenzene, and xylenes (BTEX) and total petroleum hydrocarbons (TPH) (Figures 4 and 5). In one contaminated area, BTEX levels of 706 $\eta$g/L and TPH concentrations of 104,000 $\eta$g/L were detected. TPH concentrations northwest and northeast of the site reached as high as 219,000 $\eta$g/L and 129,000 $\eta$g/L, respectively.

Analysis of free product floating on groundwater was indicative of JP-4 with variances due to slight environmental exposure. Data from the May 1994 sampling also indicate that the contamination was relatively fresh. Locations of the mobile LNAPL seem to correspond to buried tanks and fuel lines and show that free product seems to have migrated northwest to a constructed drainage ditch.

A four-quarter groundwater sampling series began in 1992. During this time period, the highest BTEX levels were recorded at 771MW-4 and 771MW-8, with respective readings ranging from 3,427 to 8,529 $\mu$g/L and 11,180 to 30,600 $\mu$g/L (Table 4). Other contaminants detected at the site include acetone at 4,300 $\mu$g/L, naphthalene at 118.3 $\mu$g/L, and total glycol at 0.93 mg/L (Table 5). The groundwater quality standards for New York are the applicable or relevant and appropriate requirements (ARARs) assigned to the Pumphouse 5 area. BTEX concentrations exceeded the ARARs in at least one or more wells for all four sampling periods.

**Table 3. Summary of Free-Product Thickness Measurements[a] at Pumphouse 5, Griffiss AFB, NY**

| Date | 771MW-1 | 771MW-2 | 771MW-3 | 771MW-4 | 771MW-5 | 771MW-6 | 771MW-7 | 771MW-8 | 771MW-9 |
|---|---|---|---|---|---|---|---|---|---|
| Jun-89 | FP[b] | ND[c] | FP | NI[d] | NI | NI | NI | NI | NI |
| Nov-91 | 2.04 | NA[e] | 4.85 | NA | NA | NA | NA | NA | NA |
| Dec-91 | NA | NA | NA | 0.01 | 0 | 0 | 5.8 | 0 | 0 |
| Apr-92 | 0.23 | 0 | 4.1 | NA | NA | NA | NA | NA | NA |
| May-92 | 0.25 | NA | 4.1 | 0 | NA | NA | 3.06 | NA | NA |
| Jun-92 | 0.18 | 0 | 4.53 | NA | NA | NA | NA | NA | NA |
| Aug-92 | 0.25 | 0 | 4.69 | NA | NA | NA | NA | NA | NA |
| Sep-92 | 0.11 | 0 | 2.02 | NA | NA | NA | NA | NA | NA |
| Oct-92 | 0.29 | 0 | 0.82 | NA | NA | NA | NA | NA | NA |
| Nov-92 | 0.32 | 0 | 0.03 | NA | NA | NA | NA | NA | NA |
| Dec-92 | 0.39 | 0 | 4.35 | NA | NA | NA | NA | NA | NA |
| Jan-93 | 0.85 | 0 | 4.14 | NA | NA | NA | NA | NA | NA |
| Feb-93 | 0 | 0 | 4.31-2.6 | NA | NA | NA | NA | NA | NA |
| Mar-93 | 0.01 | 0 | 0 | 0 | 0 | 0 | 5.4 | 0 | 0 |
| Apr-93 | 1.32-2.48 | 0 | 5.07-4.1 | 0 | 0 | 0 | 1.45-0.1 | 0.04-0.46 | 0 |
| May-93 | 0.53-0.3 | 0 | 4.77-0.1 | 0 | 0 | 0 | 0.04-0.94 | 0.59-0.4 | 0 |
| Jun-93 | 0.37-0.03 | 0 | 0.43-0.01 | 0 | 0 | 0 | 0.8-0.01 | 0.27-0.02 | 0 |
| Jul-93 | 0.05-0.02 | 0 | 0.09-0.02 | 0 | 0 | 0 | 0.23-0.16 | 0-0.06 | 0 |
| Aug-93 | 0.03 | 0 | 0.13 | 0 | 0 | 0 | 0.24 | 0.05 | 0 |
| Oct-93 | 0.06 | 0 | 4.36 | 0 | 0 | 0 | 0.02 | 0 | 0 |
| Jan-95 | 0.3 | 0 | 0.03 | 0 | 0 | 0 | 2.94 | 0.23 | 0 |

Source: Parsons Engineering Science, Inc., 1995a.

[a] Values represent product thickness in feet.
[b] FP = free product detected; level not measured.
[c] ND = free product not detected.
[d] NI = well not installed.
[e] NA = free-product n easurement not taken.

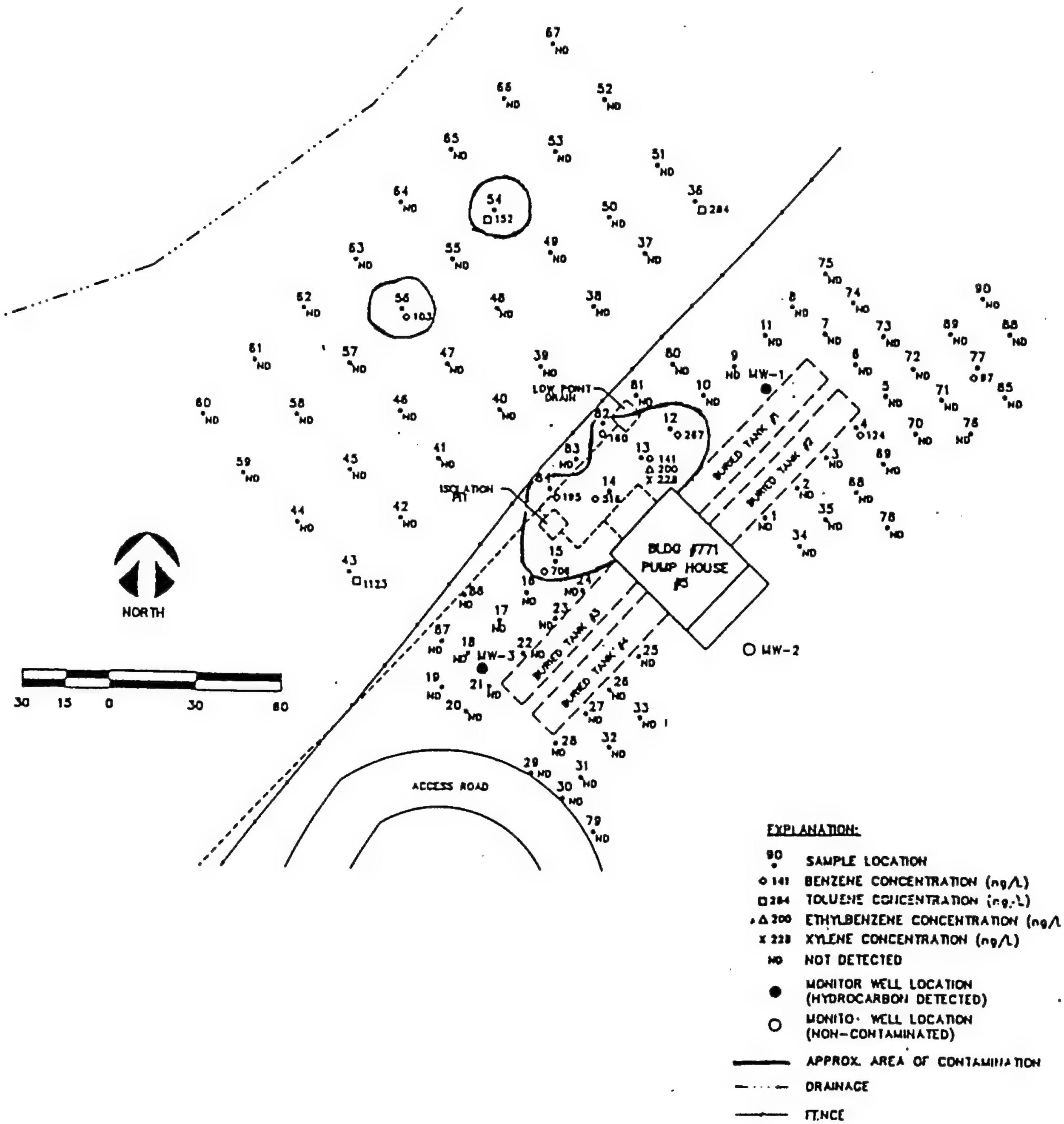


Figure 4. Pumphouse 5: BTEX Concentrations in Soil Gas (Source: Parsons Engineering Science, Inc., 1995a)

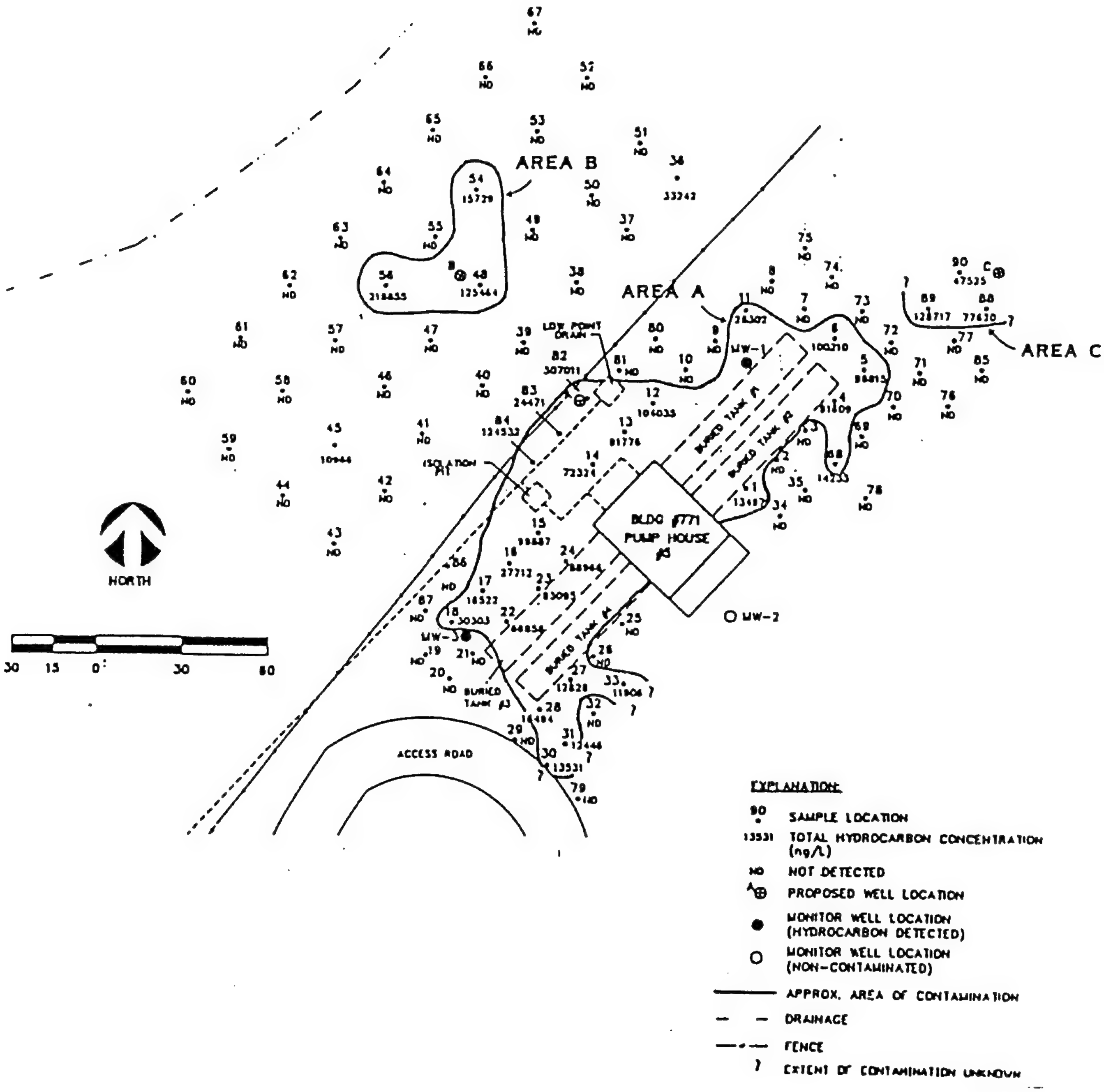


Figure 5. Pumphouse 5: TPH Concentrations in Soil Gas (Source: Parsons Engineering Science, Inc., 1995a)

Table 4. Groundwater BTEX Data at Pumphouse 5, Griffiss AFB, NY

| Well | Date | Method | Benzene (μg/L) | Toluene (μg/L) | Ethylbenzene (μg/L) | Xylenes (μg/L) | Total BTEX (μg/L) |
|---|---|---|---|---|---|---|---|
| 771MW-2 | Nov-92 | 8240 | <5 | <5 | <5 | <5 | <20 |
| | Mar-93 | 8240 | <5 | <5 | <5 | <5 | <20 |
| | Jun-93 | 8240 | <5 | <5 | <5 | <5 | <20 |
| | Sep-93 | 8240 | <1 | <1.5 | <1 | <4 | <7.5 |
| 771MW-2 (dup) | Nov-92 | 8240 | <5 | <5 | <5 | <5 | <20 |
| | Mar-93 | 8240 | 7.6 | 1.3J(a) | 1.1J | 2.2J | 12.2J |
| | June-93 | 8240 | <5 | <5 | <5 | <5 | <20 |
| | Sep-93 | 8240 | <1 | <1.5 | <1 | <4 | <7.5 |
| 771MW-4 | Jan-92 | 8020 | 5,200*(b) | 610*#(c) | 610* | 7,500* | 13,920 |
| | Nov-92 | 8240 | 3,100 | 19 | 450 | 1,200 | 4,769 |
| | Mar-93 | 8240 | 4,200JD(d) | 44J | 410 | 1,200 | 5,854JD |
| | Jun-93 | 8240 | 5,900JD | 29 | 700JD | 1,900JD | 8,529JD |
| | Sep-93 | 8240 | 3,200 | <1.5 | 47 | 180 | 3,427 |
| 771MW-5 | Jan-92 | 8020 | <0.5 | <0.5 | <0.5 | <1 | <2.5 |
| | Nov-92 | 8240 | <5 | <5 | <5 | <5 | <20 |
| | Mar-93 | 8240 | <5 | <5 | <5 | <5 | <20 |
| | Jun-93 | 8240 | <5 | <5 | <5 | <5 | <20 |
| | Sep-93 | 8240 | <1 | <1.5 | <1 | <4 | <7.5 |
| 771MW-6 | Jan-92 | 8020 | <0.5 | <0.5 | <0.5 | <1 | <2.5 |
| | Nov-92 | 8240 | 2.1J | <5 | 1.3T(e) | <5 | 2.1J |
| | Mar-93 | 8240 | 1.1JB(f) | <5 | <5 | <5 | 1.1JT |
| | Jun-93 | 8240 | <5 | <5 | <5 | <5 | <20 |
| | Sep-93 | 8240 | <1 | <1.5 | <1 | <4 | <7.5 |
| 771MW-8 | Jan-92 | 8020 | 750* | 250* | 1,100* | 6,600* | 8,700* |
| | Nov-92 | 8240 | 7,800 | 1,300 | 1,200 | 3,600 | 13,900 |
| | Mar-93 | 8240 | 8,800 | 1,400 | 1,400 | 4,300 | 15,900 |
| | Jun-93 | 8240 | 9,100JD | 1,700JD | 1,600JD | 3,600JD | 16,000JD |
| | Sep-93 | 8240 | 6,000 | 380 | 1,000 | 3,800 | 11,180 |
| 771MW-8 (dup) | Jan-92 | 8020 | 11,000* | 2,400* | 1,200* | 16,000* | 30,600* |
| | Sep-93 | 8240 | 6,000 | 380 | 1,000 | 3,800 | 11,180 |
| 771MW-9 | Jan-92 | 8020 | <-/5 | <0.5 | <0.5 | <1 | <2.5 |
| | Nov-92 | 8240 | <5 | <5 | <5 | <5 | <20 |
| | Mar-93 | 8240 | <5 | <5 | <5 | <5 | <20 |
| | Jun-93 | 8240 | <5 | <5 | <5 | <5 | <20 |
| | Sep-93 | 8240 | <1 | <1.5 | <1 | <4 | <7.5 |

Source: Parsons Engineering Science, Inc., 1995a.

(a) J - Concentration estimated.
(b) * - Results from diluted sample.
(c) # - Concentration exceeds the method range (URL).
(d) JD - Estimated result due to dilution.
(e) T - False-positive based on trip blank data.
(f) JB - Estimated quantitation: possible biased high or false-positive based on quality control (QC) data.

**Table 5. Volatile (Non-BTEX), Semivolatile, and Glycol Compounds in Groundwater by Quarter (November 1992–September 1993) at Pumphouse 5, Griffiss AFB, NY**

| Parameters | Method | Unit | 771MW-2 | 771MW-2(d) | 771MW-4 | 771MW-5 | 771MW-6 | 771MW-8 | 771MW-9 |
|---|---|---|---|---|---|---|---|---|---|
| **QUARTER 1, NOVEMBER 1992** | | | | | | | | | |
| **Volatile Organics** | | | | | | | | | |
| Acetone | SW8240 | µg/L | 12J[a] | <5 | 1900 | 6.2 | <5 | 4300 | 46 |
| 2-Hexanone | SW8240 | µg/L | <5 | < | <5 | <5 | <5 | 130 | <5 |
| Methylene Chloride | SW8240 | µg/L | 6.2B[b] | 9.5B | 7.6B | 6.9B | 7.3B | 7.8B | 7.0B |
| **Semivolatile Organics** | | | | | | | | | |
| 2-Methylnaphthalene | SW8270 | µg/L | <10 | <10 | 30.2 | <10 | <10 | 60.4 | <10 |
| Dibenzofuran | SW8270 | µg/L | <10 | <10 | <10 | <10 | <10 | 1.0J | <10 |
| Diethyl Phthalate | SW8270 | µg/L | <10 | <10 | <10 | <10 | <10 | 1.0J | 1.7J |
| Naphthalene | SW8270 | µg/L | <10 | <10 | 61.3 | <10 | <10 | 118.3 | <10 |
| Phenol | SW8270 | µg/L | <10 | <10 | 4.1R[c] | <10 | <10 | <10 | <10 |
| bis(2-ethylhexyl) phthalate | SW8270 | µg/L | <10 | <10 | <10 | <10 | <10 | <10 | 1.1J |
| **Glycols** | | | | | | | | | |
| Total Glycol | NYS DOH APC-44 | mg/L | 0.07T[d] | <0.05 | 0.08 | <0.05 | <0.05 | <0.05 | 0.12 |
| **QUARTER 2, MARCH 1993** | | | | | | | | | |
| **Volatile Organics** | | | | | | | | | |
| Acetone | SW8240 | µg/L | 3.9JB[e] | 2.9JB | <50 | 11JB | 9.1JB | <250 | <5 |
| Chloromethane | SW8240 | µg/L | 4.8JB | 8.1JB | <100 | <10 | 4.2JB | 160J | <10 |
| Methyl Ethyl Ketone | SW8240 | µg/L | <5 | <5 | <50 | 3.4J | <5 | <250 | <5 |
| Methylene Chloride | SW8240 | µg/L | 6.2JB | 5.1JB | 30JB | 3JB | 4.6JB | 210JB | 5.1JB |
| **Semivolatile Organics** | | | | | | | | | |
| 2-Methylnaphthalene | SW8270 | µg/L | <10 | <10 | 33 | <10 | <10 | 2J | <10 |
| Acenaphthene | SW8270 | µg/L | <10 | <10 | <10 | <10 | <10 | 1J | <10 |
| Fluorene | SW8270 | µg/L | <10 | <10 | <10 | <10 | <10 | 1J | <10 |
| Naphthalene | SW8270 | µg/L | <10 | <10 | <10 | 87 | <10 | <10 | 4J | <10 |
| **Glycols** | | | | | | | | | |
| Total Glycol | NYS DOH APC-44 | µg/L | 0.09J | 0.07J | <0.04 | <0.04 | 0.09J | 0.09J | 0.14J |

**Table 5. (Continued)**

| Parameters | Method | Unit | 771MW-2 | 771MW-2(d) | 771MW-4 | 771MW-5 | 771MW-6 | 771MW-8 | 771MW-9 |
|---|---|---|---|---|---|---|---|---|---|
| **QUARTER 3, JUNE 1993** | | | | | | | | | |
| **Volatile Organics** | | | | | | | | | |
| Acetone | SW8240 | µg/L | 860D[f] | 960JD | 2200JD | 21.0JB | 14.0JB | 2400JB | 18 |
| Methylene Chloride | SW8240 | µg/L | 49 | 16 | 6.5JB | 8.7JB | 7.0JB | 7.0JB | <5.0 |
| **Semivolatile Organics** | | | | | | | | | |
| 2-Methylnaphthalene | SW8270 | µg/L | <10 | <10 | 44 | <10 | <10 | 13 | <10 |
| Naphthalene | SW8270 | µg/L | <10 | <10 | 110 | <10 | <10 | 64.6 | <10 |
| Methyl Ethyl Ketone | SW8270 | µg/L | 29 | 11 | 2200JD | <5 | <5 | <5 | <5 |
| bis(2-ethylhexyl) phthalate | SW8270 | µg/L | <10 | <10 | 2.2J | 1.8J | <10 | 1.0J | <10 |
| **Glycols** | | | | | | | | | |
| Total Glycol | NYS DOH APC-44 | NA | 0.07 | 0.46 | 0.11 | <0.05 | 0.93 | 0.14 | 0.16 |
| **QUARTER 4, SEPTEMBER 1993** | | | | | | | | | |
| **Volatile Organics** | | | | | | | | | |
| Acetone | SW8240 | µg/L | 1400 | 870 | <50 | <50 | <50 | <25 | <500 |
| Methylene Chloride | SW8240 | µg/L | <10 | 12JT[g] | 17JT | 13JT | 12JT | <10 | <10 |
| **Semivolatile Organics** | | | | | | | | | |
| 2-Methylnaphthalene | SW8270 | µg/L | <4.0 | <4.4 | 46 | <4.1 | <4.1 | 18 | <4.0 |
| Naphthalene | SW8270 | µg/L | <3.0 | <3.3 | 130 | <3.1 | <3.1 | 89 | <3.0 |
| Phenol | SW8270 | µg/L | <4.0 | <4.4 | 67 | <4.1 | <4.1 | 130 | <4.0 |

(a) J - Concentration estimated.
(b) B - False-positive based on blank data.
(c) R - Data rejected due to QC data. Do not use.
(d) T - False positive based on trip blank data.
(e) JB - Estimated quantitation (possible high or low bias based on quality assurance (QA)/QC data).
(f) JD - Estimated result due to dilution.
(g) JT - Estimated quantitation (possible high or low bias based on trip blank).

# 3.0 PROJECT ACTIVITIES

The field activities discussed in the following sections are planned for the bioslurper pilot test at Griffiss AFB. Additional details about the activities are presented in the overall Test Plan and Technical Protocol. As appropriate, specific sections in the overall Test Plan and Technical Protocol are referenced. Table 6 presents the schedule of activities for the Bioslurper Initiative at Griffiss AFB.

## 3.1 Mobilization to the Site

After the site-specific Test Plan is approved, Battelle staff will mobilize equipment to the site. Some of the equipment will be shipped via air express to Griffiss AFB prior to staff arrival. The base point-of-contact (POC) will have been asked in advance to find a suitable holding facility to receive the bioslurper pilot test equipment so that it will be easily accessible to the Battelle staff when they arrive with the remainder of the equipment. The exact mobilization date will be confirmed with the base POC as far in advance of fieldwork as is possible. The Battelle POC will provide the base POC with information on each Battelle employee who will be on site. Battelle personnel will be mobilized to the site after confirmation that the shipped equipment has been received by Griffiss AFB.

## 3.2 Site Characterization Tests

### 3.2.1 Baildown Tests

The baildown test is the primary test for selection of the bioslurper test well. Baildown tests also are useful for the evaluation of actual versus apparent free-product thicknesses. Baildown tests will be performed at wells that contain measurable thicknesses of LNAPL to estimate the relative LNAPL recovery potential for each well. In most cases, the well exhibiting the highest rate of LNAPL recovery will be selected for the bioslurper extraction well. A sample of free-phase LNAPL will be collected at this point for analyses of boiling point distribution and BTEX concentration. Based on available data, wells 771MW-1, 771MW-3, 771MW-7, and 771MW-8 are the most likely candidates for use as the pilot test extraction well. Detailed procedures for the baildown tests are provided in Section 5.6 of the overall Test Plan and Technical Protocol (Battelle, 1995).

### 3.2.2 Soil Gas Survey (Limited)

A small-scale soil gas survey may be conducted to identify the best location for installation of the bioslurping system. The soil gas survey will be conducted in the areas where historical site data indicated the highest contamination levels. These areas will be surveyed to select the locations for installation of the soil gas monitoring points. Monitoring points will be located in areas that exhibit the following soil gas characteristics.

1. Relatively high TPH concentrations (10,000 ppmv or greater).
2. Relatively low oxygen concentrations (between 0% and 2%).
3. Relatively high carbon dioxide concentrations (depending on soil type, between 2% and 10% or greater).

Additional information on the soil gas survey is provided in Section 5.2 of the overall Test Plan and Technical Protocol.

### 3.2.3 Monitoring Point Installation

Monitoring points must be installed to determine the radius of influence of the bioslurper system in the vadose zone. A general arrangement of the bioslurping well and monitoring points is shown in Figure 6.

Upon completion of the initial soil gas survey and baildown tests, at least three soil gas monitoring points will be installed (unless existing monitoring points are available for use) to measure soil gas changes that occur during bioslurper operation. These monitoring points should be located in highly contaminated soils overlying the free-phase plume and should be positioned to allow detailed monitoring of the in situ changes in soil gas composition caused by the bioslurper system. A schematic diagram of a typical monitoring point is shown in Figure 7. Information on monitoring point installation can be found in Section 4.2.1 of the overall Test Plan and Technical Protocol (Battelle, 1995).

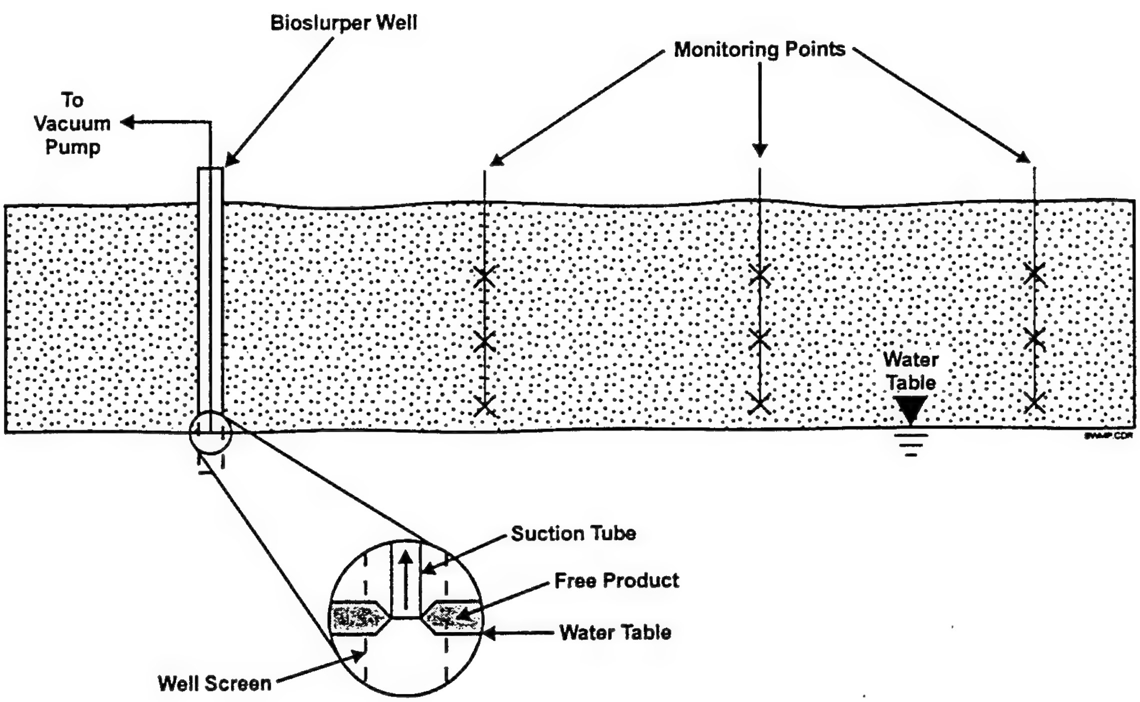


**Figure 6. General Bioslurper Well and Monitoring Point Arrangement**

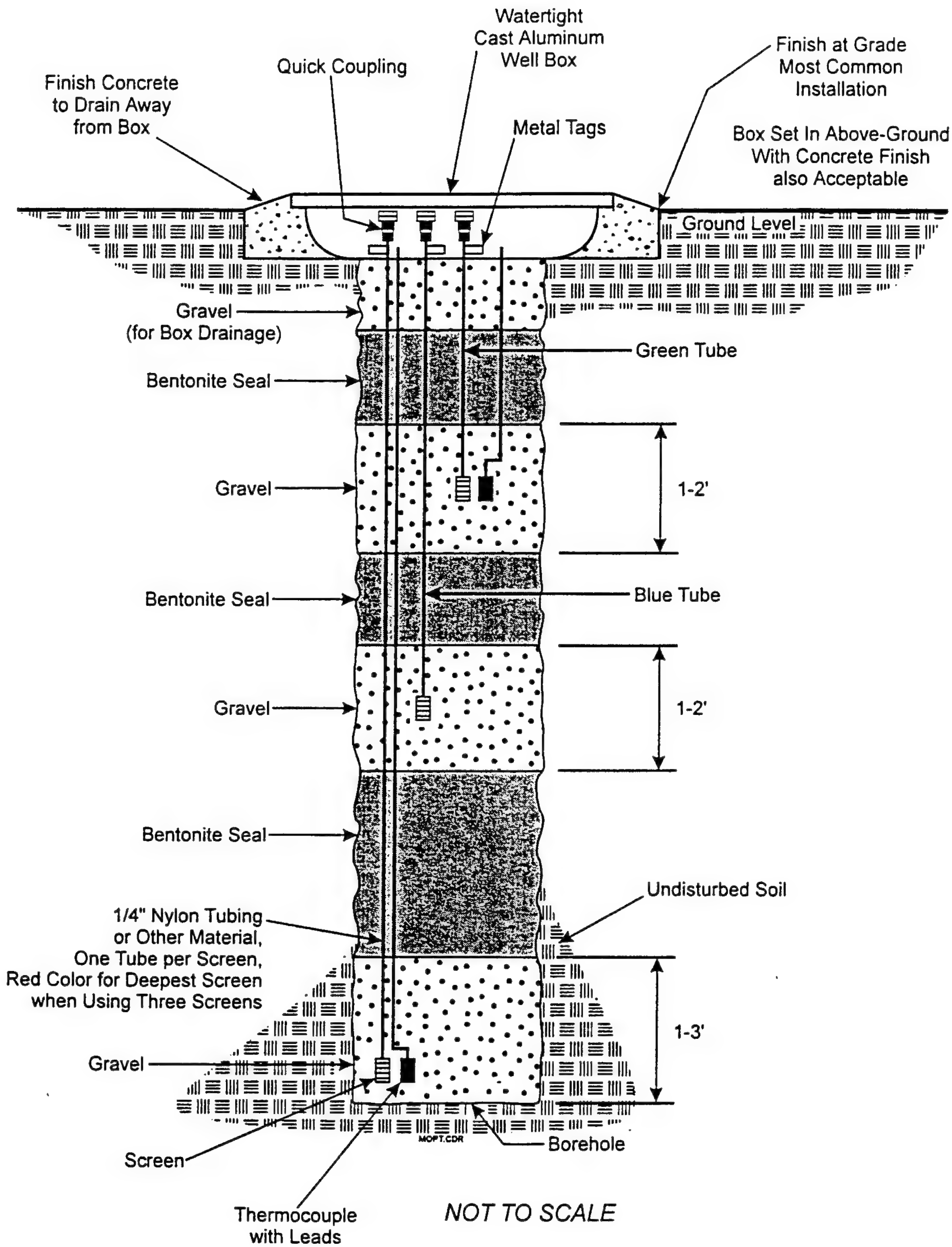


**Figure 7. Schematic Diagram of a Typical Monitoring Point**

### 3.2.4 Soil Sampling

Soil samples will be collected from soil borings to determine the physical and chemical composition of the soil near the bioslurper test site. Soil samples will be collected from the boreholes advanced for monitoring point installation at two or three locations at the site chosen for the bioslurper test. Generally, samples will be collected from the capillary fringe over the free product.

Soil samples from each boring will be analyzed for BTEX, bulk density, moisture content, particle size distribution, porosity, and TPH. Section 5.5.1 of the overall Test Plan and Technical Protocol (Battelle, 1995) contains additional information on field measurements and sample collection procedures for soil sampling.

## 3.3 Bioslurper System Installation and Operation

Once the well to be used for the bioslurper test installation at Griffiss AFB has been identified, the bioslurper pump and support equipment will be installed and pilot testing will be initiated.

### 3.3.1 System Setup

After the preliminary site characterization has been completed and the bioslurper candidate well has been selected, the shipped equipment will be mobilized from the holding facility to the test site, and the bioslurper system will be assembled. Figure 8 shows a flow diagram of the bioslurper process. Figure 9 illustrates a typical bioslurper well that will be used at Griffiss AFB.

Before the LNAPL recovery tests are initiated, all relevant baseline field data will be collected and recorded. These data will include soil gas concentrations, initial soil gas pressures, the depth to groundwater, and the LNAPL thickness. Ambient soil and all atmospheric conditions (e.g., temperature, barometric pressure) also will be recorded. All emergency equipment (i.e., emergency shutoff switches and fire extinguishers) will be installed and checked for proper operation at this time.

A clear, level 20- by 10-ft area near the well selected for the bioslurper test installation will be identified to station the equipment required for bioslurper system operation. Additional information on bioslurper system installation is provided in Section 6.0 of the overall Test Plan and Technical Protocol (Battelle, 1995).

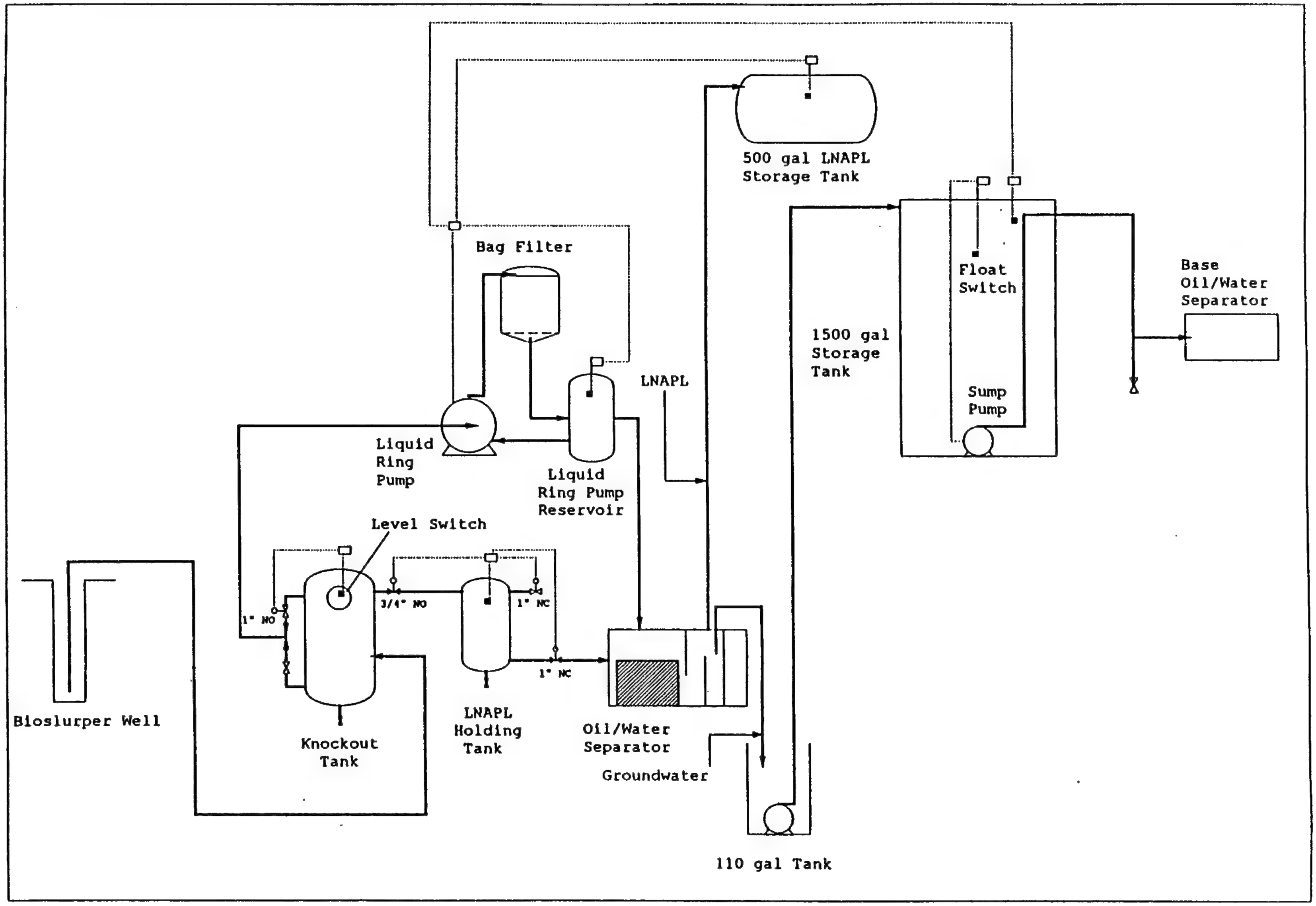


Figure 8. Bioslurper Process Flow at Pumphouse 5, Griffiss AFB

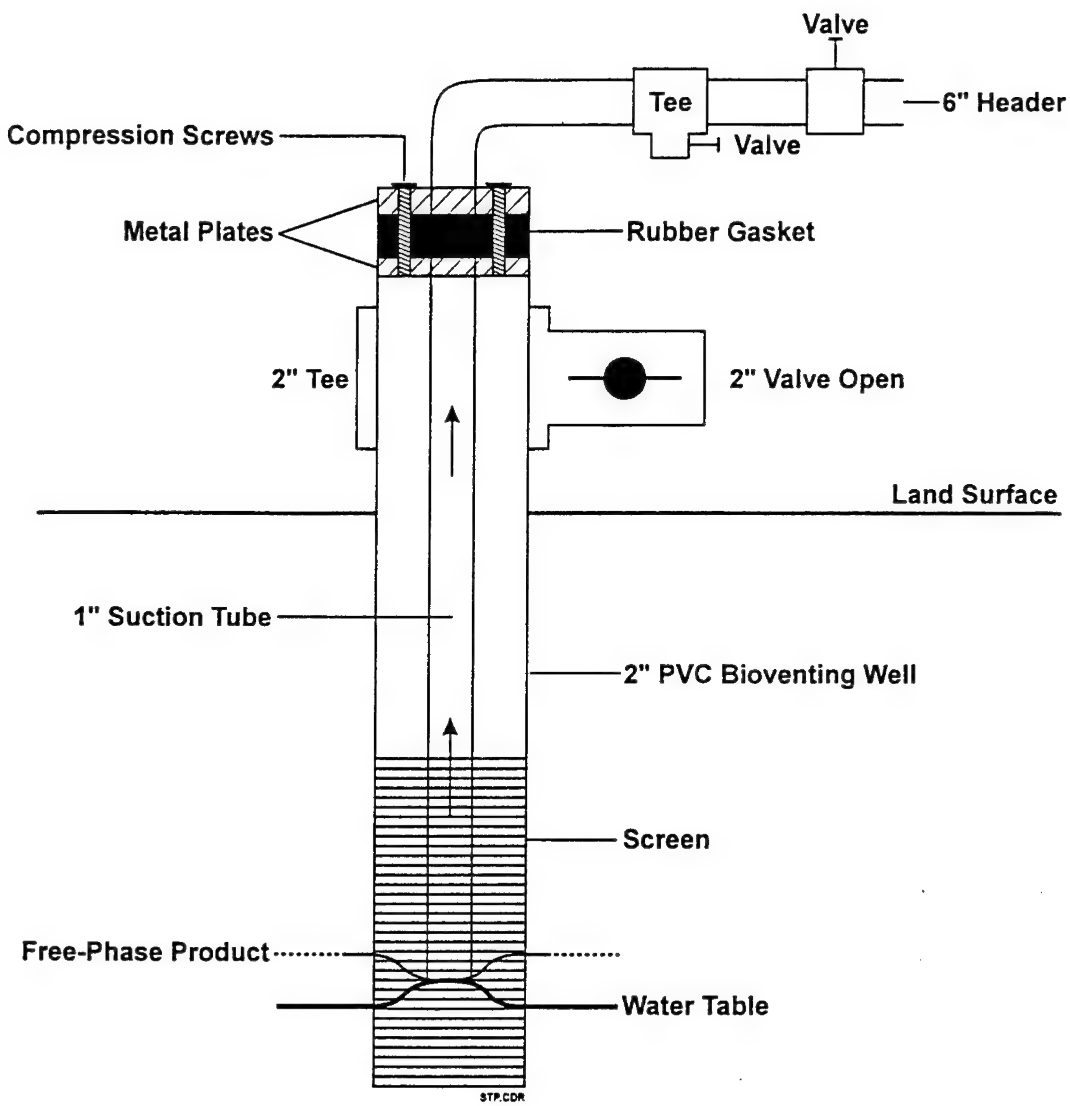


**Figure 9.** **Schematic Diagram Illustrating Slurper Tube Placement and Valve Position for the Skimmer Pump Test**

### 3.3.2 System Shakedown

A brief startup test will be conducted to ensure that the system is constructed properly and operates safely. All system components will be checked for problems and/or malfunctions. A checklist will be provided to document the system shakedown.

### 3.3.3 System Startup and Test Operations

After installation is complete and the bioslurper system is confirmed to be operating properly, the LNAPL recovery tests will be started. The Bioslurper Initiative has been designed to evaluate the effectiveness of bioslurping as an LNAPL recovery test technology relative to conventional gravity-driven LNAPL recovery technologies. The Bioslurper Initiative includes three separate LNAPL recovery tests: (1) a skimmer pump test, (2) a bioslurper pump test, and (3) a drawdown pump test. The three recovery tests are described in detail in Section 7.3 of the overall Test Plan and Technical Protocol (Battelle, 1995).

The bioslurper system operating parameters that will be measured during operation are vapor discharge, aqueous effluent, LNAPL recovery volume rates, vapor discharge volume rates, and groundwater discharge volume rates. Vapor monitoring will consist of periodic monitoring of TPH using hand-held instruments supplemented by two samples collected for detailed laboratory analysis. Two samples of aqueous effluent will be collected for analyses of BTEX and TPH. Recovered LNAPL volume will be recorded using an in-line flow-totalizing meter. The off-gas discharge volume will be measured using a calibrated pitot tube, and the groundwater discharge volume will be recorded using an in-line flow-totalizing meter. Section 8.0 of the overall Test Plan and Technical Protocol (Battelle, 1995) describes process monitoring of the bioslurper system.

### 3.3.4 Soil Gas Profile/Oxygen Radius of Influence Test

Changes in soil gas profiles will be measured before and during the bioslurper pump test. Soil gas will be monitored for concentrations of oxygen, carbon dioxide, and TPH using field instruments. These measurements will be used to determine the oxygen radius of influence of the bioslurper.

### 3.3.5 Soil Gas Permeability Tests

A soil gas permeability test will be conducted concurrently with startup of the bioslurper pump test. Soil gas permeability data will support the process of estimating the vadose zone radius of influence of the bioslurper system. Soil gas permeability results also will aid in determining the number of wells required if it is decided to treat the site with a full-scale bioslurper system. The soil gas permeability test method is described in Section 5.7 of the overall Test Plan and Technical Protocol (Battelle, 1995).

### 3.3.6 LNAPL and Groundwater Level Monitoring

During the bioslurper pump test, the LNAPL and groundwater levels will be monitored in a well adjacent to the extraction well if such a well exists. The top of the monitoring well will be sealed from the atmosphere so the subsurface vacuum will be contained. Additional information for the monitoring of fluid levels is provided in Section 4.3.4 of the overall Test Plan and Technical Protocol (Battelle, 1995).

### 3.3.7 In Situ Respiration Test

An in situ respiration test will be conducted after completion of the bioslurper pilot tests. The in situ respiration test will involve injection of air and helium into selected soil gas monitoring points followed by monitoring changes in concentrations of oxygen, carbon dioxide, TPH, and helium in soil gas at the injection point. Measurement of the soil gas composition typically will be conducted at 2, 4, 6, and 8 hours and then every 4 to 12 hours for about 2 days. Timing of the tests will be adjusted based on the oxygen-use rate. If oxygen depletion occurs rapidly, more frequent monitoring will be required. If oxygen depletion is slow, less frequent readings will be acceptable. The oxygen utilization rate will be used to estimate the biodegradation rate at the site. Further information on the procedures and data collection of the in situ respiration test is provided in Section 5.8 of the overall Test Plan and Technical Protocol (Battelle, 1995).

### 3.3.8 Extended Testing

The Air Force has the option of extending the operation of the bioslurper system for up to 6 months if LNAPL recovery rates are promising and long-term vapor and aqueous discharge requirement have been established. If extended testing is to be performed, the Air Force will need to provide electrical power for long-term operation of the bioslurper pump. Disposition of all generated wastes and routine operation and maintenance of the system will be the Air Force's responsibility. Battelle will provide technical support during the extended testing operation.

## 3.4 Demobilization

Once all necessary tests have been completed at the Griffiss AFB site, the equipment will be disassembled by Battelle staff. The equipment then will be moved back to the holding facility, where it will remain until its next destination is determined. Battelle staff will receive this information and will be responsible for shipment of the equipment to the next site before they leave Griffiss AFB.

# 4.0 BIOSLURPER SYSTEM DISCHARGE

## 4.1 Vapor Discharge Disposition

The bioslurper system can be expected to generate a vapor discharge in the range of 1.0 to 130 lb/day TPH. This value is based on the average discharge rates at three bioslurper test sites (Johnston Atoll, Travis AFB, and Wright-Patterson AFB) that are contaminated with a similar type of fuel as that found at Pumphouse 5. The discharge value will vary depending on concentrations in soil gas and the permeability of the soil. The data for benzene and TPH discharge levels for six previous bioslurper sites are presented in Table 7.

The Air Force is requesting that, during the short-term pilot test, direct discharge of the system vapor emissions be allowed. Data will be collected during the test to quantify the mass of hydrocarbons extracted in the vapor phase. The data will assist in determining long-term treatment requirements for possible full-scale implementation. To quantify the mass of hydrocarbons released to the atmosphere, two Summa canister samples will be collected for a Modified TO-14 laboratory

analysis of BTEX, TPH, and the 10 highest-concentration hydrocarbon constituents detected. The two samples will be collected during the 4-day bioslurper extraction test.

**Table 7. Benzene and TPH Vapor Discharge Levels at Previous Bioslurper Test Sites**

| Site Location | Fuel Type | Extraction Rate (scfm) | Benzene (ppmv) | TPH (ppmv) | Benzene Discharge (lb/day) | TPH Discharge (lb/day) |
|---|---|---|---|---|---|---|
| Andrews AFB | No. 2 Fuel Oil | 8.0 | 16 | 2,000 | 0.0010 | 0.20 |
| Site 1, Bolling AFB | No. 2 Fuel Oil | 4.0 | 0.20 | 153 | 0.00030 | 0.0090 |
| Site 2, Bolling AFB | Gasoline | 21 | 370 | 70,000 | 2.3 | 470 |
| Johnston Atoll | Jet Fuel | 10 | 0.60 | 975 | 0.0017 | 5.7 |
| Travis AFB | Jet Fuel | 20 | 100 | 10,800 | 0.58 | 130 |
| Wright-Patterson AFB | Jet Fuel | 3.0 | ND | 595 | 0 | 1.0 |

ND = Not detected

To ensure the safety and regulatory compliance of the bioslurper system, field soil gas screening instruments will be used to supplement vapor discharge concentration monitoring.

### 4.2 Aqueous Influent/Effluent Disposition

Operation of the bioslurper system will generate an aqueous waste discharge that will be passed through an oil/water separator (OWS) prior to discharge to a base OWS that is connected to the local sanitary sewer. The bioslurper system OWS is rated for 10 gpm, and the base OWS is rated at 300 gpm.

### 4.3 Free-Product Recovery Disposition

The bioslurper system will recover free-phase product from the pilot tests performed at Griffiss AFB. Recovered free product will be turned over to the base for disposal and/or recycling. The volume of free product recovered from the base will not be known until the tests have been performed.

# 5.0 SCHEDULE

The schedule for the bioslurper fieldwork at Griffiss AFB will depend on approval of this Test Plan. Battelle will determine a definitive schedule as soon as possible after approval is received. Battelle will have two to three staff members on site for approximately 2 weeks to conduct all necessary pilot testing. At the conclusion of the field testing at Griffiss AFB, all staff will return their base passes. Battelle staff will remove all bioslurper field testing equipment from the base before they leave the site.

# 6.0 PROJECT SUPPORT ROLES

This section outlines some of the major functions of personnel from Battelle, Griffiss AFB, and AFCEE during the bioslurper field test.

## 6.1 Battelle Activities

The obligations of Battelle in the Bioslurper Initiative at Griffiss AFB will be to supply the staff and equipment necessary to perform all the tests on the bioslurper system. Battelle also will provide technical support in the areas of water and vapor discharge permitting, digging permits, staff support during the extended testing period, and any other technical areas that need to be addressed.

## 6.2 Griffiss AFB Support Activities

To support the necessary field tests at Griffiss AFB, the base must be able to provide the following:

1. Any digging permits and utility clearances that need to be obtained prior to the initiation of the fieldwork. Any underground utilities should be clearly marked to reduce the chance of utility damage and/or personal injury during soil gas probe and possible well installation. Battelle will not begin field operations without these clearances and permits.

2. The Air Force will be responsible for obtaining base and site clearance for the Battelle staff that will be working at the base. The base POC will be furnished with all necessary information on each staff member at least 1 week prior to field startup.

3. Access to the local sanitary sewer must be furnished so that Battelle staff can discharge the bioslurper aqueous effluent directly to the base OWS.

4. Regulatory approval, if required, must be obtained by the base POC prior to startup of the bioslurper pilot test. The base POC will obtain all necessary base permits prior to mobilization to the site. Battelle will provide technical assistance in preparing regulatory approval documents.

5. The base also will be responsible for the disposition of all waste generated from the pilot testing. Such waste includes any soil cuttings generated from drilling, and all aqueous wastestreams produced from the bioslurper tests. All free product recovered from the bioslurper operation will be disposed of or recycled by the base. Battelle will provide technical assistance in disposing of the waste generated from the bioslurper pilot test.

6. Before field activities begin, the Health and Safety Plan will be finalized with information provided by the base POC. Table 8 is a checklist for the information required to complete the Health and Safety Plan. All emergency information will be obtained by the Site Health and Safety Office before operations begin.

Table 8. Health and Safety Information Checklist

| Contacts | Name | Telephone Number |
|---|---|---|
| **Emergency** | | |
| Hospital | | |
| Fire Department | | |
| Ambulance and Paramedics | | |
| Police Department | | |
| EPA Emergency Response Team | | |
| **Program** | | |
| Air Force | Patrick Haas | (210) 536-4314 |
| Battelle | Jeff Kittel<br>Eric Drescher | (614) 424-6122<br>(614) 424-3038 |
| Griffiss AFB | Cathy Jerrard | (315) 330-2275 |
| Other | | |
| **Emergency Routes** | | |
| Hospital | | |
| Other | | |

### 6.3 AFCEE Activities

The AFCEE POC will act as a liaison between Battelle and Griffiss AFB staff. The AFCEE POC will ensure that all necessary permits are obtained and that the space required to house the bioslurper field equipment is found.

The following is a listing of Battelle, AFCEE, and Griffiss AFB staff who can be contacted in case of emergency and/or for required technical support during the Bioslurper Initiative tests at Griffiss AFB.

| | | |
|---|---|---|
| Battelle POCs | Jeff Kittel | (614) 424-6122 |
| | Eric Drescher | (614) 424-3088 |
| AFCEE POC | Patrick Haas | (210) 536-4314 |
| Griffiss AFB POC | Cathy Jerrard | (609) 724-3323 |
| Regulatory POCs | | |

## 7.0 REFERENCES


Battelle. 1995. *Test Plan and Technical Protocol for Bioslurping*. Prepared by Battelle Columbus Operations for the U.S. Air Force Center for Environmental Excellence, Brooks Air Force Base, Texas.

Parsons Engineering Science, Inc. 1995a. *Work Plan for a Treatability Study in Support of the Intrinsic Remediation (Natural Attenuation) Option at Pumphouse 5 (Building 771)*. Prepared by Parsons Engineering Science, Inc. for the Air Force Center for Environmental Excellence and Griffiss Air Force Base. June.

Parsons Engineering Science, Inc. 1995b. *Building 771 (Pumphouse 5) Engineering Evaluation/Cost Analysis Report*. February.

# APPENDIX B

## LABORATORY ANALYTICAL REPORTS

# AIR TOXICS LTD.

SAMPLE NAME: GRF-0GS-1

ID#: 9609015-01A

EPA METHOD TO-14 GC/MS Full Scan

| | | | |
|---|---|---|---|
| File Name: | 1090513 | Date of Collection: | 8/22/96 |
| Dil. Factor: | 47300 | Date of Analysis: | 9/5/96 |

| Compound | Det. Limit (ppbv) | Amount (ppbv) |
|---|---|---|
| Freon 12 | 24000 | Not Detected |
| Freon 114 | 24000 | Not Detected |
| Chloromethane | 24000 | Not Detected |
| Vinyl Chloride | 24000 | Not Detected |
| Bromomethane | 24000 | Not Detected |
| Chloroethane | 24000 | Not Detected |
| Freon 11 | 24000 | Not Detected |
| 1,1-Dichloroethene | 24000 | Not Detected |
| Freon 113 | 24000 | Not Detected |
| Methylene Chloride | 24000 | Not Detected |
| 1,1-Dichloroethane | 24000 | Not Detected |
| cis-1,2-Dichloroethene | 24000 | Not Detected |
| Chloroform | 24000 | Not Detected |
| 1,1,1-Trichloroethane | 24000 | Not Detected |
| Carbon Tetrachloride | 24000 | Not Detected |
| Benzene | 24000 | 130000 |
| 1,2-Dichloroethane | 24000 | Not Detected |
| Trichloroethene | 24000 | Not Detected |
| 1,2-Dichloropropane | 24000 | Not Detected |
| cis-1,3-Dichloropropene | 24000 | Not Detected |
| Toluene | 24000 | Not Detected |
| trans-1,3-Dichloropropene | 24000 | Not Detected |
| 1,1,2-Trichloroethane | 24000 | Not Detected |
| Tetrachloroethene | 24000 | Not Detected |
| Ethylene Dibromide | 24000 | Not Detected |
| Chlorobenzene | 24000 | Not Detected |
| Ethyl Benzene | 24000 | 61000 |
| m,p-Xylene | 24000 | 240000 |
| o-Xylene | 24000 | Not Detected |
| Styrene | 24000 | Not Detected |
| 1,1,2,2-Tetrachloroethane | 24000 | Not Detected |
| 1,3,5-Trimethylbenzene | 24000 | 35000 |
| 1,2,4-Trimethylbenzene | 24000 | 99000 |
| 1,3-Dichlorobenzene | 24000 | Not Detected |
| 1,4-Dichlorobenzene | 24000 | Not Detected |
| Chlorotoluene | 24000 | Not Detected |
| 1,2-Dichlorobenzene | 24000 | Not Detected |
| 1,2,4-Trichlorobenzene | 24000 | Not Detected |
| Hexachlorobutadiene | 24000 | Not Detected |

# AIR TOXICS LTD.

SAMPLE NAME: GRF-0GS-1

ID#: 9609015-01A

EPA METHOD TO-14 GC/MS Full Scan

| | | | |
|---|---|---|---|
| **File Name:** | **1090513** | **Date of Collection:** | **8/22/96** |
| **Dil. Factor:** | **47300** | **Date of Analysis:** | **9/5/96** |

| Compound | Det. Limit (ppbv) | Amount (ppbv) |
|---|---|---|
| Propylene | 95000 | Not Detected |
| 1,3-Butadiene | 95000 | Not Detected |
| Acetone | 95000 | Not Detected |
| Carbon Disulfide | 95000 | Not Detected |
| 2-Propanol | 95000 | Not Detected |
| trans-1,2-Dichloroethene | 95000 | Not Detected |
| Vinyl Acetate | 95000 | Not Detected |
| Chloroprene | 95000 | Not Detected |
| 2-Butanone (Methyl Ethyl Ketone) | 95000 | Not Detected |
| Hexane | 95000 | 8000000 |
| Tetrahydrofuran | 95000 | Not Detected |
| Cyclohexane | 95000 | Not Detected |
| 1,4-Dioxane | 95000 | Not Detected |
| Bromodichloromethane | 95000 | Not Detected |
| 4-Methyl-2-pentanone | 95000 | Not Detected |
| 2-Hexanone | 95000 | Not Detected |
| Dibromochloromethane | 95000 | Not Detected |
| Bromoform | 95000 | Not Detected |
| 4-Ethyltoluene | 95000 | Not Detected |
| Ethanol | 95000 | Not Detected |
| Methyl tert-Butyl Ether | 95000 | Not Detected |
| Heptane | 95000 | 2100000 |
| TPH* | 240000 | 38000000 |

*Total Petroleum Hydrocarbons referenced to Jet Fuel (MW = 156).

## TENTATIVELY IDENTIFIED COMPOUNDS - Top 10 Reported

| Compound | CAS Number | Match Quality | Amount (ppbv) |
|---|---|---|---|
| Butane, 2-methyl- | 78-78-4 | Manual ID | 740000 |
| Pentane | 109-66-0 | 90 % | 980000 |
| Butane, 2,2-dimethyl- | 75-83-2 | 83 % | 800000 |
| Pentane, 2-methyl- | 107-83-5 | 91 % | 6600000 |
| Pentane, 3-methyl- | 96-14-0 | 90 % | 3700000 |
| Cyclopentane, methyl- | 96-37-7 | 80 % | 1900000 |
| Hexane, 2-methyl- | 591-76-4 | 87 % | 2000000 |
| Unknown | NA | NA | 1200000 |
| Unknown Branched Alkane | NA | NA | 2400000 |
| Cyclohexane, methyl- | 108-87-2 | 93 % | 1100000 |

**Container Type: 1 Liter Summa Canister**

| Surrogates | % Recovery | Method Limits |
|---|---|---|
| Octafluorotoluene | 89 | 70-130 |
| Toluene-d8 | 109 | 70-130 |
| 4-Bromofluorobenzene | 102 | 70-130 |

# AIR TOXICS LTD.

SAMPLE NAME: GFS-0GS-2

ID#: 9609015-02A

**EPA METHOD TO-14 GC/MS Full Scan**

| | | |
|---|---|---|
| File Name: | 1090515 | Date of Collection: 8/23/96 |
| Dil. Factor: | 41800 | Date of Analysis: 9/5/96 |

| Compound | Det. Limit (ppbv) | Amount (ppbv) |
|---|---|---|
| Freon 12 | 21000 | Not Detected |
| Freon 114 | 21000 | Not Detected |
| Chloromethane | 21000 | Not Detected |
| Vinyl Chloride | 21000 | Not Detected |
| Bromomethane | 21000 | Not Detected |
| Chloroethane | 21000 | Not Detected |
| Freon 11 | 21000 | Not Detected |
| 1,1-Dichloroethene | 21000 | Not Detected |
| Freon 113 | 21000 | Not Detected |
| Methylene Chloride | 21000 | Not Detected |
| 1,1-Dichloroethane | 21000 | Not Detected |
| cis-1,2-Dichloroethene | 21000 | Not Detected |
| Chloroform | 21000 | Not Detected |
| 1,1,1-Trichloroethane | 21000 | Not Detected |
| Carbon Tetrachloride | 21000 | Not Detected |
| Benzene | 21000 | 100000 |
| 1,2-Dichloroethane | 21000 | Not Detected |
| Trichloroethene | 21000 | Not Detected |
| 1,2-Dichloropropane | 21000 | Not Detected |
| cis-1,3-Dichloropropene | 21000 | Not Detected |
| Toluene | 21000 | Not Detected |
| trans-1,3-Dichloropropene | 21000 | Not Detected |
| 1,1,2-Trichloroethane | 21000 | Not Detected |
| Tetrachloroethene | 21000 | Not Detected |
| Ethylene Dibromide | 21000 | Not Detected |
| Chlorobenzene | 21000 | Not Detected |
| Ethyl Benzene | 21000 | 57000 |
| m,p-Xylene | 21000 | 220000 |
| o-Xylene | 21000 | Not Detected |
| Styrene | 21000 | Not Detected |
| 1,1,2,2-Tetrachloroethane | 21000 | Not Detected |
| 1,3,5-Trimethylbenzene | 21000 | 36000 |
| 1,2,4-Trimethylbenzene | 21000 | 80000 |
| 1,3-Dichlorobenzene | 21000 | Not Detected |
| 1,4-Dichlorobenzene | 21000 | Not Detected |
| Chlorotoluene | 21000 | Not Detected |
| 1,2-Dichlorobenzene | 21000 | Not Detected |
| 1,2,4-Trichlorobenzene | 21000 | Not Detected |
| Hexachlorobutadiene | 21000 | Not Detected |

# AIR TOXICS LTD.

SAMPLE NAME: GFS-0GS-2

ID#: 9609015-02A

**EPA METHOD TO-14 GC/MS Full Scan**

| | | |
|---|---|---|
| File Name: | 1090515 | Date of Collection: 8/23/96 |
| Dil. Factor: | 41800 | Date of Analysis: 9/5/96 |

| Compound | Det. Limit (ppbv) | Amount (ppbv) |
|---|---|---|
| Propylene | 84000 | Not Detected |
| 1,3-Butadiene | 84000 | Not Detected |
| Acetone | 84000 | Not Detected |
| Carbon Disulfide | 84000 | Not Detected |
| 2-Propanol | 84000 | Not Detected |
| trans-1,2-Dichloroethene | 84000 | Not Detected |
| Vinyl Acetate | 84000 | Not Detected |
| Chloroprene | 84000 | Not Detected |
| 2-Butanone (Methyl Ethyl Ketone) | 84000 | Not Detected |
| Hexane | 84000 | 7000000 |
| Tetrahydrofuran | 84000 | Not Detected |
| Cyclohexane | 84000 | Not Detected |
| 1,4-Dioxane | 84000 | Not Detected |
| Bromodichloromethane | 84000 | Not Detected |
| 4-Methyl-2-pentanone | 84000 | Not Detected |
| 2-Hexanone | 84000 | Not Detected |
| Dibromochloromethane | 84000 | Not Detected |
| Bromoform | 84000 | Not Detected |
| 4-Ethyltoluene | 84000 | Not Detected |
| Ethanol | 84000 | Not Detected |
| Methyl tert-Butyl Ether | 84000 | Not Detected |
| Heptane | 84000 | 2000000 |
| TPH* | 210000 | 35000000 |

*Total Petroleum Hydrocarbons referenced to Jet Fuel (MW = 156).

**TENTATIVELY IDENTIFIED COMPOUNDS - Top 10 Reported**

| Compound | CAS Number | Match Quality | Amount (ppbv) |
|---|---|---|---|
| Pentane | 109-66-0 | 90 % | 820000 |
| Butane, 2,2-dimethyl- | 75-83-2 | 83 % | 700000 |
| Pentane, 2-methyl- | 107-83-5 | 91 % | 5600000 |
| Pentane, 3-methyl- | 96-14-0 | 90 % | 3100000 |
| Cyclopentane, methyl- | 96-37-7 | 80 % | 1600000 |
| Hexane, 2-methyl- | 591-76-4 | 90 % | 1800000 |
| Unknown | NA | NA | 1200000 |
| Hexane, 3-methyl- | 589-34-4 | 80 % | 2400000 |
| Cyclohexane, methyl- | 108-87-2 | 94 % | 1200000 |
| Hexane, 2,5-dimethyl- | 592-13-2 | 80 % | 780000 |

**Container Type: 1 Liter Summa Canister**

| Surrogates | % Recovery | Method Limits |
|---|---|---|
| Octafluorotoluene | 86 | 70-130 |
| Toluene-d8 | 107 | 70-130 |
| 4-Bromofluorobenzene | 98 | 70-130 |

# AIR TOXICS LTD.

SAMPLE NAME: Lab Blank

ID#: 9609015-03A

EPA METHOD TO-14 GC/MS Full Scan

| | | |
|---|---|---|
| File Name: | 1090505 | Date of Collection: NA |
| Dil. Factor: | 1.00 | Date of Analysis: 9/5/96 |

| Compound | Det. Limit (ppbv) | Amount (ppbv) |
|---|---|---|
| Freon 12 | 0.50 | Not Detected |
| Freon 114 | 0.50 | Not Detected |
| Chloromethane | 0.50 | Not Detected |
| Vinyl Chloride | 0.50 | Not Detected |
| Bromomethane | 0.50 | Not Detected |
| Chloroethane | 0.50 | Not Detected |
| Freon 11 | 0.50 | Not Detected |
| 1,1-Dichloroethene | 0.50 | Not Detected |
| Freon 113 | 0.50 | Not Detected |
| Methylene Chloride | 0.50 | Not Detected |
| 1,1-Dichloroethane | 0.50 | Not Detected |
| cis-1,2-Dichloroethene | 0.50 | Not Detected |
| Chloroform | 0.50 | Not Detected |
| 1,1,1-Trichloroethane | 0.50 | Not Detected |
| Carbon Tetrachloride | 0.50 | Not Detected |
| Benzene | 0.50 | Not Detected |
| 1,2-Dichloroethane | 0.50 | Not Detected |
| Trichloroethene | 0.50 | Not Detected |
| 1,2-Dichloropropane | 0.50 | Not Detected |
| cis-1,3-Dichloropropene | 0.50 | Not Detected |
| Toluene | 0.50 | Not Detected |
| trans-1,3-Dichloropropene | 0.50 | Not Detected |
| 1,1,2-Trichloroethane | 0.50 | Not Detected |
| Tetrachloroethene | 0.50 | Not Detected |
| Ethylene Dibromide | 0.50 | Not Detected |
| Chlorobenzene | 0.50 | Not Detected |
| Ethyl Benzene | 0.50 | Not Detected |
| m,p-Xylene | 0.50 | Not Detected |
| o-Xylene | 0.50 | Not Detected |
| Styrene | 0.50 | Not Detected |
| 1,1,2,2-Tetrachloroethane | 0.50 | Not Detected |
| 1,3,5-Trimethylbenzene | 0.50 | Not Detected |
| 1,2,4-Trimethylbenzene | 0.50 | Not Detected |
| 1,3-Dichlorobenzene | 0.50 | Not Detected |
| 1,4-Dichlorobenzene | 0.50 | Not Detected |
| Chlorotoluene | 0.50 | Not Detected |
| 1,2-Dichlorobenzene | 0.50 | Not Detected |
| 1,2,4-Trichlorobenzene | 0.50 | Not Detected |
| Hexachlorobutadiene | 0.50 | Not Detected |

# AIR TOXICS LTD.

SAMPLE NAME: Lab Blank

ID#: 9609015-03A

**EPA METHOD TO-14 GC/MS Full Scan**

| | | | |
|---|---|---|---|
| **File Name:** | **1090505** | **Date of Collection:** | **NA** |
| **Dil. Factor:** | **1.00** | **Date of Analysis:** | **9/5/96** |

| Compound | Det. Limit (ppbv) | Amount (ppbv) |
|---|---|---|
| Propylene | 2.0 | Not Detected |
| 1,3-Butadiene | 2.0 | Not Detected |
| Acetone | 2.0 | Not Detected |
| Carbon Disulfide | 2.0 | Not Detected |
| 2-Propanol | 2.0 | Not Detected |
| trans-1,2-Dichloroethene | 2.0 | Not Detected |
| Vinyl Acetate | 2.0 | Not Detected |
| Chloroprene | 2.0 | Not Detected |
| 2-Butanone (Methyl Ethyl Ketone) | 2.0 | Not Detected |
| Hexane | 2.0 | Not Detected |
| Tetrahydrofuran | 2.0 | Not Detected |
| Cyclohexane | 2.0 | Not Detected |
| 1,4-Dioxane | 2.0 | Not Detected |
| Bromodichloromethane | 2.0 | Not Detected |
| 4-Methyl-2-pentanone | 2.0 | Not Detected |
| 2-Hexanone | 2.0 | Not Detected |
| Dibromochloromethane | 2.0 | Not Detected |
| Bromoform | 2.0 | Not Detected |
| 4-Ethyltoluene | 2.0 | Not Detected |
| Ethanol | 2.0 | Not Detected |
| Methyl tert-Butyl Ether | 2.0 | Not Detected |
| Heptane | 2.0 | Not Detected |
| TPH* | 5.0 | Not Detected |

*Total Petroleum Hydrocarbons referenced to Jet Fuel (MW = 156).

**TENTATIVELY IDENTIFIED COMPOUNDS - Top 10 Reported**

| Compound | CAS Number | Match Quality | Amount (ppbv) |
|---|---|---|---|
| None Identified | | | |

**Container Type: NA**

| Surrogates | % Recovery | Method Limits |
|---|---|---|
| **Octafluorotoluene** | **96** | **70-130** |
| **Toluene-d8** | **106** | **70-130** |
| **4-Bromofluorobenzene** | **96** | **70-130** |

# AIR TOXICS LTD.
AN ENVIRONMENTAL ANALYTICAL LABORATORY

180 BLUE RAVINE ROAD, SUITE B
FOLSOM, CA 95630-4719
(916) 985-1000 FAX: (916) 985-1020

# CHAIN-OF-CUSTODY RECORD

No 008266 Page 1 of 1

Contact Person MATT PLACE
Company BATTELLE
Address 505 KING AVE City COLUMBUS State OH Zip 43201
Phone 614 424 4531 FAX 614 424 3667
Collected By: Signature [signature]

**Project info:**
P.O. #
Project # G462201-30A0201
Project Name GRIFFIS AFB BIOSLURPER

**Turn Around Time:**
☒ Normal
☐ Rush ______ Specify

| Lab I.D. | Field Sample I.D. | Date & Time | Analyses Requested | Canister Pressure / Vacuum Initial | Final | Receipt |
|---|---|---|---|---|---|---|
| 01A | GRF-OGS-1 | 8/22/96-1850 | TO-14 QUANTITATION OF ALL 55 STANDARD TARGET COMPOUNDS, TPH AS JET FUEL, AND LIBRARY SCAN OF 10 LARGEST NON-TARGET PEAKS. | 30"Hg | 6"Hg | 1.5"Hg |
| 02A | GFS-OGS-2 | 8/23/96-1734 | TO-14 QUANTITATION OF ALL 55 STANDARD TARGET COMPOUNDS, TPH AS JET FUEL AND LIBRARY SCAN OF 10 LARGEST NON TARGET PEAKS | 30"Hg | 0"Hg | 1.0"Hg |

9/4/96

Relinquished By: (Signature) [signature] Date/Time 9/3/96 1704 Print Name
Relinquished By: (Signature) Date/Time Received By: (Signature) Date/Time
Relinquished By: (Signature) Date/Time Received By: (Signature) [signature] Date/Time ATL 9/4/96 930

Notes:

| Lab Use Only | Shipper Name | Air Bill # | Opened By: | Date/Time | Temp. (°C) | Condition | Custody Seals Intact? | Work Order # |
|---|---|---|---|---|---|---|---|---|
| | Fed-X | 1263942884 | TS | 9/4/96 930 | Amb | Good | Yes No None N/A (None circled) | 9609015 |

Form 1293 rev. 06

# AIR TOXICS LTD.
AN ENVIRONMENTAL ANALYTICAL LABORATORY

180 BLUE RAVINE ROAD, SUITE B
FOLSOM, CA 95630-4719
(916) 985-1000 FAX: (916) 985-1020

# CHAIN-OF-CUSTODY RECORD

Nº 008266 Page 1 of 1

Contact Person MATT PLACE
Company BATTELLE
Address 505 KING AVE City COLUMBUS State OH Zip 43201
Phone 614 424 4531 FAX 614 424 3667
Collected By: Signature [signature]

Project info:
P.O. #
Project # G462201-30A0201
Project Name GRIFFISAFB BIOSLURPER

Turn Around Time:
☒ Normal
☐ Rush ______ Specify

| Lab I.D. | Field Sample I.D. | Date & Time | Analyses Requested | Canister Pressure / Vacuum Initial | Final | Receipt |
|---|---|---|---|---|---|---|
| | GRF-OGS-1 | 8/22/96-1850 | TO-14 QUANTITATION OF ALL 55 STANDARD TARGET COMPOUNDS, TPH AS JET FUEL, AND LIBRARY SCAN OF 10 LARGEST NON-TARGET PEAKS. | 30" Hg | 0" Hg | |
| | GFS-OGS-2 | 8/23/96-1734 | TO-14 QUANTITATION OF ALL 55 STANDARD TARGET COMPOUNDS, TPH AS JET FUEL, AND LIBRARY SCAN OF 10 LARGEST NON TARGET PEAKS | 30" Hg | 0" Hg | |

Relinquished By: (Signature) [signature] Date/Time 9/3/96 Print Name 1704
Relinquished By: (Signature) Date/Time Received By: (Signature) Date/Time
Relinquished By: (Signature) Date/Time Received By: (Signature) Date/Time

Notes:

| Lab Use Only | Shipper Name | Air Bill # | Opened By: | Date/Time | Temp. (°C) | Condition | Custody Seals Intact? | Work Order # |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | Yes No None N/A | |

**Alpha Analytical, Inc.**
255 Glendale Avenue, Suite 21
Sparks, Nevada 89431
(702) 355-1044
FAX: 702-355-0406
1-800-283-1183

e-mail: alpha@powernet.net
http//www.powernet.net/~alpha

2505 Chandler Avenue, Suite 1
Las Vegas, Nevada 89120
(702) 498-3312
FAX: 702-736-7523
1-800-283-1183

# ANALYTICAL REPORT

Battelle
505 King Ave
Columbus Ohio 43201

Job#:
Phone: (614) 424-6199
Attn: Al Pollock

Sampled: 08/19/96 Received: 08/27/96 Analyzed: 08/28/96

Matrix: [ X ] Soil [ ] Water [ ] Waste

Analysis Requested: TPH - Total Petroleum Hydrocarbons-Purgeable Quantitated As Gasoline
BTEX - Benzene,Toluene,Ethylbenzene,Xylenes

Methodology: TPH - Modified 8015/DHS LUFT Manual/BLS-191
BTEX - EPA Method 624/8240

TPH/BTXE Results:

| Client ID/ Lab ID | Parameter | Concentration | Detection Limit | |
|---|---|---|---|---|
| GRF A1 /BMI082796-04 | TPH | 4,700 | 500 | mg/Kg |
| | Benzene | ND | 1,000 | ug/Kg |
| | Toluene | ND | 1,000 | ug/Kg |
| | Ethylbenzene | 23,000 | 1,000 | ug/Kg |
| | Total Xylenes | 82,000 | 1,000 | ug/Kg |
| GRF A2 /BMI082796-05 | TPH | 4,700 | 500 | mg/Kg |
| | Benzene | ND | 1,000 | ug/Kg |
| | Toluene | ND | 1,000 | ug/Kg |
| | Ethylbenzene | 21,000 | 1,000 | ug/Kg |
| | Total Xylenes | 82,000 | 1,000 | ug/Kg |

ND - Not Detected

Approved By: Roger L. Scholl Date: 9/10/96
Roger L. Scholl, Ph.D.
Laboratory Director

**Alpha Analytical, Inc.**
255 Glendale Avenue, Suite 21
Sparks, Nevada 89431
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2505 Chandler Avenue, Suite 1
Las Vegas, Nevada 89120
(702) 498-3312
FAX: 702-736-7523
1-800-283-1183

# ANALYTICAL REPORT

Battelle
505 King Ave
Columbus Ohio 43201

Job#:
Phone: (614) 424-6199
Attn: Al Pollock

Sampled: 08/22-23/96 Received: 08/27/96 Analyzed: 08/29-30/96

Matrix: [ ] Soil [ X ] Water [ ] Waste

Analysis Requested: TPH - Total Petroleum Hydrocarbons-Purgeable Quantitated As Gasoline
BTEX - Benzene, Toluene, Ethylbenzene, Xylenes

Methodology: TPH - Modified 8015/DHS LUFT Manual/BLS-191
BTEX - Method 624/8240

Results:

| Client ID/ Lab ID | Parameter | Concentration | Detection Limit | |
|---|---|---|---|---|
| GFS DW1 /BMI082796-01 | TPH (Purgeable) | 3.5 | 2.5 | mg/L |
| | Benzene | 400 | 5.0 | ug/L |
| | Toluene | 26 | 5.0 | ug/L |
| | Ethylbenzene | 180 | 5.0 | ug/L |
| | Total Xylenes | 840 | 5.0 | ug/L |
| GFS DW2 /BMI082796-02 | TPH (Purgeable) | 2.8 | 0.50 | mg/L |
| | Benzene | 220 | 1.0 | ug/L |
| | Toluene | 27 | 1.0 | ug/L |
| | Ethylbenzene | 110 | 1.0 | ug/L |
| | Total Xylenes | 440 | 1.0 | ug/L |

Approved by: Roger L. Scholl Date: 9/9/96
Roger L. Scholl, Ph.D.
Laboratory Director

**Alpha Analytical, Inc.**
255 Glendale Avenue, Suite 21
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(702) 498-3312
FAX: 702-736-7523
1-800-283-1183

# ANALYTICAL REPORT

Battelle
505 King Ave
Columbus Ohio 43201

Job#:
Phone: (614) 424-6199
Attn: Al Pollock

Sampled: 08/20/96 Received: 08/27/96 Analyzed: 08/29/96

Matrix: [ ] Soil [ ] Water [ X ] Other

Analysis Requested: BTEX - Benzene,Toluene,Xylenes,Ethylbenzene

Methodology: BTEX - EPA Method 624/8240

Results:

| Client ID/ Lab ID | Parameter | Concentration ug/Kg | Detection Limit ug/Kg |
|---|---|---|---|
| GFS FP 1 /BMI082796-03 | Benzene | 1,300 | 210 |
| | Toluene | 200 | 210 |
| | Ethylbenzene | 3,800 | 210 |
| | Total Xylenes | 18,000 | 210 |

Approved by: Roger L. Scholl Date: 9/9/96
Roger L. Scholl, Ph.D.
Laboratory Director

**Alpha Analytical, Inc.**
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2505 Chandler Avenue, Suite 1
Las Vegas, Nevada 89120
(702) 498-3312
FAX: 702-736-7523
1-800-283-1183

# ANALYTICAL REPORT

Battelle
505 King Ave
Columbus Ohio 43201

Job#:
Phone: (614) 424-6199
Attn: Al Pollock

Alpha Analytical Number: BMI082796-03

Client I.D. Number: GFS FP1

Date Sampled: 08/20/96

Date Received: 08/27/96

| C-range Compounds | Method | Percentage of Total | Detection Limit (Not Applicable) | Date Analyzed |
|---|---|---|---|---|
| >C8 | GC/FID | 44.40 | NA | 09/04/96 |
| C9 | GC/FID | 9.60 | NA | 09/04/96 |
| C10 | GC/FID | 11.01 | NA | 09/04/96 |
| C11 | GC/FID | 12.26 | NA | 09/04/96 |
| C12 | GC/FID | 11.34 | NA | 09/04/96 |
| C13 | GC/FID | 7.25 | NA | 09/04/96 |
| C14 | GC/FID | 2.52 | NA | 09/04/96 |
| C15 | GC/FID | 0.71 | NA | 09/04/96 |
| C17 | GC/FID | 0.27 | NA | 09/04/96 |
| >C18 | GC/FID | 0.63 | NA | 09/04/96 |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |

Approved by: Roger L. Scholl

Date: 9/9/96

Roger L. Scholl, Ph.D.
Laboratory Director

# Laboratory Analysis Report

Sierra Environmental Monitoring, Inc.

ALPHA ANALYTICAL
255 GLENDALE AVENUE, SUITE 21
SPARKS NV 89431

Date : 9/10/96
Client : ALP-855
Taken by: CLIENT
Report : 17283
PO# :



| ple | Collected Date | Time | MOISTURE CONTENT % | SIEVE ANALYSIS % PASSING | DENSITY G/CM3 | POROSITY | | |
|---|---|---|---|---|---|---|---|---|
| 082796-04 - GRF A 1 | 8/19/96 | : | 14.0 | YES | 1.42 | 46.4 | | |
| 082796-05 - GRF A 2 | 8/19/96 | : | 14.9 | YES | 1.46 | 44.9 | | |

ved By:

report is applicable only to the sample received by the laboratory. The liability of the laboratory is limited to the amount paid his report. This report is for the exclusive use of the client to whom it is addressed and upon the condition that the client es all liability for the further distribution of the report or its contents.

1135 Financial Blvd.
Reno, NV 89502
Phone (702) 857-2400

m F. Pillsbury

John C. Seher
Manager

Sierra
Environmental
Monitoring, Inc.

**Sierra Environmental Monitoring, Inc.**
**1135 Financial Bloulevard**
**Reno, NV 89502**
**702-857-2400 FAX 702-857-2404**

# SIEVE ANALYSIS REPORT

| | | | |
|---|---|---|---|
| Client | Alpha Analytical, Inc. | Analytical Method | ASTM |
| Sample Name | BMI082796-04 - GRF A 1 | Sample Date | 08/19/96 |
| SEM Lab Number | 9408-0887 | Analysis Date | 09/06/96 |

| U. S. Standard Sieve Size | Percent Passing |
|---|---|
| 1 inch | 100% |
| No. 4 | 80% |
| No. 8 | 0.7% |
| No. 10 | 0.6% |
| No. 16 | 0.6% |
| No. 30 | 0.5% |
| No. 40 | 0.5% |
| No. 50 | 0.4% |
| No. 100 | 0.2% |
| No. 200 | <0.1 % |

Approved by: ______

John Seher, Laboratory Manager

Sierra
Environmental
Monitoring, Inc.

**Sierra Environmental Monitoring, Inc.**
**1135 Financial Bloulevard**
**Reno, NV 89502**
**702-857-2400 FAX 702-857-2404**

# SIEVE ANALYSIS REPORT

| | | | |
|---|---|---|---|
| Client | Alpha Analytical, Inc. | Analytical Method | ASTM |
| Sample Name | BMI082796-05 - GRF A 2 | Sample Date | 08/19/96 |
| SEM Lab Number | 9608-0888 | Analysis Date | 09/06/96 |

| U. S. Standard Sieve Size | Percent Passing |
|---|---|
| 1 inch | 100% |
| 1/2 inch | 95% |
| No. 4 | 79% |
| No. 8 | 66% |
| No. 10 | 62% |
| No. 16 | 53% |
| No. 30 | 50% |
| No. 40 | 47% |
| No. 50 | 39% |
| No. 100 | 23% |
| No. 200 | 5% |

Approved by: [signature]

John Seher, Laboratory Manager

Address ______
City, State, Zip ______
Phone Number ______ Fax ______

Phone (702) 355-1044
Fax (702) 355-0406

| Client Name Battelle | P.O. # | Job # |
|---|---|---|
| Address | PWS # | DWR # |
| City, State, Zip | Phone # | Fax # |

Sampled by | Report Attention

Analyses Required

| Time Sampled | Date Sampled | Matrix* See Key Below | Office Use Only Lab ID Number | Sample Description | Total and type of containers ** See below | TPH as Jet fuel | BTXE | Sieve Analysis | Bulk Density | Moisture Content | Porosity | Boiling Pt |  |  |  |  |  |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 8/22 | AQ | BM1082796-01 | GFS DW1 | | X | X | | | | | | | | | | |
| | 8/23 | AQ | 02 | " " 2 | | X | X | | | | | | | | | | |
| | 8/20 | OT | 03 | " FP1 | | | X | | | | | X | See Randy Free Prod. | | | | |
| | 8/19 | SO | 04 | GRF A1 | | X | X | X | X | X | X | ~~X~~ | | | | | |
| | 8/19 | SO | 05 | " " 2 | | X | X | X | X | X | X | | | | | | |
| | | | | | | ~~X~~ | ~~X~~ | ~~X~~ | ~~X~~ | ~~X~~ | ~~X~~ | | | | | | |

REMARKS:

~~A-~~ 03 is Free Product See Randy

| | Signature | Print Name | Company | Date | Time |
|---|---|---|---|---|---|
| Relinquished by | | | | | |
| Received by | Kathrine Zsuga | KZ Souza | AAI | 8-27-96 | 1000 |
| Relinquished by | [signature] | Craig Giesy | AAI | 8-27-96 | ~~5~~ 4:40pm |
| Received by | John Kobza | John Kobza | SEM | 8-27-96 | 4:40pm |
| Relinquished by | | | | | |
| Received by | | | | | |

NOTE: Samples are discarded 60 days after results are reported unless other arrangements are made. Hazardous samples will be returned to client or disposed of at client expense.

Key: AQ - Aqueous SO - Soil WA - Waste OT - Other **: L-Liter V-Voa S-Soil Jar O-Orbo T-Tedlar B-Brass P-Plastic OT-Other

**Battelle**
Columbus Laboratories

# CHAIN OF CUSTODY RECORD

Form No. ____________

TOTAL P.002

**Proj. No.** #G462201—30A07.01

**Project Title** GRIFFISS AFB BIOSLURPER

**SAMPLERS: (Signature)** Matt C[signature]

| DATE | TIME | SAMPLE I.D. | TPH ASJCT FU | BTEX | 11-SEIVE ANALYSIS | BULK DENSITY | MOISTURE CONT | POROSITY | BOILING PT. D.S | Container No. | Number of Containers | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 8/22/96 | 1930 | GFS-DW-1 | X | X | | | | | | | 1 | WATER |
| 8/23/96 | 1730 | GFS-DW-2 | X | X | | | | | | | 1 | WATER |
| 8/20/96 | 0745 | GFS-FP-1 | | X | | | | | X | | 1 | FREE PRODUCT |
| 8/19/96 | 1500 | GRF-A-1 | X | X | X | X | X | X | | | 1 | SOIL |
| 8/19/96 | 1500 | GRF-A-2 | X | X | X | X | X | X | | | 1 | SOIL |

| Relinquished by: (Signature) | Date/Time | Received by: (Signature) | Relinquished by: (Signature) | Date/Time | Received by: (Signature) |
|---|---|---|---|---|---|
| [signature] | 8/26/96 1245 | | | | |

| Relinquished by: (Signature) | Date/Time | Received by: (Signature) | Relinquished by: (Signature) | Date/Time | Received by: (Signature) |
|---|---|---|---|---|---|
| | | | | | |

| Relinquished by: (Signature) | Date/Time | Received for Laboratory by: (Signature) | Date/Time | Remarks |
|---|---|---|---|---|
| | | | | |

Page 1 of 1

# APPENDIX C

# SYSTEM CHECKLIST

## Checklist for System Shakedown

Site: GRIFFISS AFB

Date: 8/20/96

Operator's Initials: MP

| Equipment | Check if Okay | Comments |
|---|---|---|
| Liquid Ring Pump | ✓ | |
| Aqueous Effluent Transfer Pump | ✓ | |
| Oil/Water Separator | ✓ | |
| Vapor Flow Meter | ✓ | |
| Fuel Flow Meter | ✓ | |
| Water Flow Meter | ✓ | |
| Emergency Shut off Float Switch<br>-Effluent Transfer Tank | ✓ | |
| Analytical Field Instrumentation<br>-GasTechtor $O_2/CO_2$ Analyzer<br>-TraceTechtor Hydrocarbon Analyzer<br>-Oil/Water Interface Probe<br>-Magnehelic Boards<br>-Thermocouple Thermometer | <br>✓<br>✓<br>✓<br>✓<br>✓ | |

# APPENDIX D

# DATA SHEETS FROM THE SHORT-TERM PILOT TEST

ATMOSPHERIC OBSERVATIONS

Site: GRIFFISS AFB, NY

Operators: MATT PLACE, BOB JANOSY, DAN KRAFT

| Date/Time | Ambient Temperature | Relative Humidity | Barometric Pressure |
|---|---|---|---|
| MON, AUG 19 | ≈ 80°F | | |
| TUES, AUG 20 | ≈ 75°F | | |
| WED, AUG 21 | ≈ 78°F | | |
| THUR, AUG 22 | | | |
| FRI, AUG 23 | | | |
| SAT, AUG 24 | ≈ 70°F | | |
| SUN, AUG 25 | | | |
| MON, AUG 26 | ≈ 70°F | | |
| TUES, AUG 27 | | | |
| WED, AUG 28 | 61°F | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
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### Baildown Test Record Sheet

Site: GRIFFISS AFB, NY

Well Identification: MW-7

Well Diameter (OD/ID): ______

Date at Start of Test: 8/19/96

Sampler's Initials: ______

Time at Start of Test: 13:08

Initial Readings

| Depth to Groundwater (ft) | Depth to LNAPL (ft) | LNAPL Thickness (ft) | Total Volume Bailed ~~(L)~~ (gal) |
|---|---|---|---|
| 19.58 | 12.81 | 6.77 | 2 gal fuel |

Test Data

| Sample Collection Time | Depth to Groundwater (ft) | Depth to LNAPL (ft) | LNAPL Thickness (ft) |
|---|---|---|---|
| 13:08 | 17.21 | 16.90 | 0.31 |
| 13:10 | 17.10 | 16.65 | 0.45 |
| 13:12 | 17.05 | 16.44 | 0.61 |
| 13:14 | 17.00 | 16.27 | 0.73 |
| 13:16 | 16.97 | 16.10 | 0.87 |
| 13:20 | 16.93 | 15.92 | 1.01 |
| 13:23 | 16.90 | 15.78 | 1.12 |
| 13:30 | 16.83 | 15.50 | 1.33 |
| 13:35 | 16.78 | 15.33 | 1.45 |
| 13:45 | 16.70 | 15.15 | 1.55 |
| 14:08 | 16.54 | 14.90 | 1.64 |
| 14:36 | 16.52 | 14.82 | 1.70 |

**Figure 9. Typical Baildown Test Record Sheet**

## Baildown Test Record Sheet

Site: GRIFFISS AFB, NY

Well Identification: MW-7

Well Diameter (OD/ID): ______

Date at Start of Test: 8/19/96

Sampler's Initials: ______

Time at Start of Test: 13:08

Initial Readings

| Depth to Groundwater (ft) | Depth to LNAPL (ft) | LNAPL Thickness (ft) | Total Volume Bailed (L) |
|---|---|---|---|
| | | | |

Test Data (CONTINUED)

8/20/96

| Sample Collection Time | Depth to Groundwater (ft) | Depth to LNAPL (ft) | LNAPL Thickness (ft) |
|---|---|---|---|
| 08:25 | 17.57 | 15.09 | 2.48 |
| 08:46 | 18.94 | 16.39 | 2.55 |
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READINGS FROM RISER PIPE

Figure 9. Typical Baildown Test Record Sheet

## Baildown Test Record Sheet

Site: GRIFFISS AFB, NY

Well Identification: MW-3

Well Diameter (OD/ID): ______

Date at Start of Test: 8/19/96

Sampler's Initials: ______

Time at Start of Test: 1347

Initial Readings

| Depth to Groundwater (ft) | Depth to LNAPL (ft) | LNAPL Thickness (ft) | Total Volume Bailed ~~(L)~~ [gal] |
|---|---|---|---|
| 19.50 | 14.75 | 4.75 | 1.0 gal fuel |

Test Data

| Sample Collection Time | Depth to Groundwater (ft) | Depth to LNAPL (ft) | LNAPL Thickness (ft) |
|---|---|---|---|
| 1347 | 17.18 | 17.14 | 0.04 |
| 1349 | 16.79 | 16.71 | 0.08 |
| 1352 | 16.48 | 16.35 | 0.13 |
| 1356 | 16.36 | 16.20 | 0.16 |
| 1400 | 16.32 | 16.10 | 0.22 |
| 1405 | 16.32 | 16.04 | 0.28 |
| 1438 | 16.42 | 15.93 | 0.49 |
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Figure 9. Typical Baildown Test Record Sheet

## Baildown Test Record Sheet

Site: GRIFFISS AFB, NY

Well Identification: MW-1

Well Diameter (OD/ID): ____________

Date at Start of Test: 8/19/96 Sampler's Initials: ______

Time at Start of Test: 1414

Initial Readings

| Depth to Groundwater (ft) | Depth to LNAPL (ft) | LNAPL Thickness (ft) | Total Volume Bailed ~~(X)~~ [gal] |
|---|---|---|---|
| 17.96 | 15.50 | 2.46 | 0.5 gal fuel |

Test Data

| Sample Collection Time | Depth to Groundwater (ft) | Depth to LNAPL (ft) | LNAPL Thickness (ft) |
|---|---|---|---|
| 1414 | 17.13 | 17.08 | 0.05 |
| 1417 | 17.04 | 16.93 | 0.11 |
| 1421 | 17.00 | 16.85 | 0.15 |
| 1428 | 16.98 | 16.82 | 0.16 |
| 1434 | 16.98 | 16.79 | 0.19 |
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Figure 9. Typical Baildown Test Record Sheet

## Baildown Test Record Sheet

Site: GRIFFISS AFB, NY

Well Identification: MW-8

Well Diameter (OD/ID): ____________

Date at Start of Test: 8/19/96 Sampler's Initials: ______

Time at Start of Test: 1441

Initial Readings

| Depth to Groundwater (ft) | Depth to LNAPL (ft) | LNAPL Thickness (ft) | Total Volume Bailed ~~(L)~~ (gal) |
|---|---|---|---|
| 20.42 | 19.31 | 1.11 | 1/8 gal fuel |

Test Data

| Sample Collection Time | Depth to Groundwater (ft) | Depth to LNAPL (ft) | LNAPL Thickness (ft) |
|---|---|---|---|
| 1441 | 19.20 | 19.11 | 0.09 |
| 1445 | 18.93 | 18.65 | 0.28 |
| 1451 | 19.05 | 18.53 | 0.52 |
| 1456 | 19.12 | 18.50 | 0.62 |
| 1503 | 19.17 | 18.52 | 0.65 |
| 1516 | 19.20 | 18.49 | 0.71 |
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Figure 9. Typical Baildown Test Record Sheet

**Bioslurping Pilot Test**
**(Data Sheet 2)**
**Pilot Test Pumping Data**

Page ___ of ___

Site: GRIFFISS AFB, NY

Start Date: 8/20/96

Operators: MATT PLACE, BOB JANOSY, DAN KRAFT

Start Time: 1030

Test Type: SKIMMER

Well ID: MW-7

Depth to Groundwater: 19.58 Depth to Fuel: 12.81

Depth of Tube: 19.5 ft. below top, OF RISER PIPE

| Date/Time | Run Time | Vapor Extraction: Stack Pressure (in. $H_2O$) | Carbon Drums (in. $H_2O$) | Flowrate (scfm) | TANK ~~Pump Stack~~ Temp ~~(°C)~~ °F | Pump Head Vacuum (in. Hg) | Extraction Well Vacuum (in. $H_2O$) |
|---|---|---|---|---|---|---|---|
| 8/20/1800 | 7.5 | 0.27 | | | 122.0 | 17 | |
| 8/21 0730 | 21.2 | 0.22 | | | 118.0 | 17.5 | |
| 8/21 1900 | 32.3 | 0.24 | | | 117.0 | 17.5 | |
| 8/22/0730 | 45.3 | 0.11 | | | 114.5 | 17.5 | |
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Figure 11. Typical Record Sheets for Bioslurper Pilot Testing (Continued)

**Bioslurping Pilot Test**
**(Data Sheet 2)**
**Pilot Test Pumping Data**

Page ____ of ____

Site: GRIFFISS AFB, NY

Start Date: 8/22/96

Operators: MATT PLACE, BOB JANOSY, DAN KRAFT

Start Time: 0810

Test Type: BIOSLURPER

Well ID: MW-7

Depth to Groundwater: ________ Depth to Fuel: ________

Depth of Tube: ________

| Date/Time | Run Time | Vapor Extraction: Stack Pressure (in. $H_2O$) | Vapor Extraction: Carbon Drums (in. $H_2O$) | Vapor Extraction: Flowrate (scfm) | TANK ~~Pump Stack~~ Temp ~~(°C)~~ °F | Pump Head Vacuum (in. Hg) | Extraction Well Vacuum (in. ~~$H_2O$~~ Hg) |
|---|---|---|---|---|---|---|---|
| 8/22/1835 | 56.1 | 0.005 | | | 115.6 | 25 | 23 |
| 8/23/0730 | 69.1 | 0.005 | | | 106.0 | 25 | 23 |
| 8/23/1700 | 78.6 | 0.005 | | | 113.6 | 25 | 23 |
| 8/24/0730 | 92.7 | 0.01 | | | 110.8 | 25 | 22 |
| 8/24/0745 | — SHUTDOWN | BIOSLURPER | ON | MW-7 — | | | |
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Figure 11. Typical Record Sheets for Bioslurper Pilot Testing (Continued)

Bioslurping Pilot Test
(Data Sheet 2)
Pilot Test Pumping Data

Page ____ of ____

Site: GRIFFISS AFB, NY

Start Date: 8/24/96

Operators: MATT PLACE, BOB JANOSY

Start Time: 0930

Test Type: BIOSLURPER

Well ID: MW-3

Depth to Groundwater: 21.09 Depth to Fuel: 16.38

Depth of Tube: ____

| Date/Time | Run Time | Vapor Extraction: Stack Pressure (in. $H_2O$) | Vapor Extraction: Carbon Drums (in. $H_2O$) | Vapor Extraction: Flowrate (scfm) | TANK ~~Pump Stack~~ Temp ~~(°C)~~ °F | Pump Head Vacuum (in. Hg) | Extraction Well Vacuum (in. ~~H₂O~~) Hg |
|---|---|---|---|---|---|---|---|
| 8/24/0930 | INITIAL READING | 0.005 | | | | 23.5 | 8 |
| 8/24/1900 | 102.6 | 0.03 | | | 96.6 | 23 | 7.5 |
| 8/25/0840 | 116.0 | 0.01 | | | 94.4 | 23.5 | 7 |
| 8/25/1730 | 124.7 | 0.035 | | | 101.0 | 23 | 7 |
| 8/26/0830 | 139.4 | 0.025 | | | 96.2 | -23.5 | 7 |
| 8/26/0925 | — | SHUTDOWN VACUUM ENHANCED CONFIGURATION | | | | | |
| | | | IN MW-3 — | | | | |
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Figure 11. Typical Record Sheets for Bioslurper Pilot Testing (Continued)

**Bioslurping Pilot Test**
**(Data Sheet 2)**
**Pilot Test Pumping Data**

Page ____ of ____

Site: GRIFFISS AFB, NY

Operators: M. PLARE, B. JANOSY, J. THOMAS

Test Type: DRAWDOWN

Depth to Groundwater: ________ Depth to Fuel: ________

Start Date: 8/26/96

Start Time: 0925

Well ID: MW-7

Depth of Tube: ________

| Date/Time | Run Time | Vapor Extraction: Stack Pressure (in. $H_2O$) | Vapor Extraction: Carbon Drums (in. $H_2O$) | Vapor Extraction: Flowrate (scfm) | TANK ~~Pump Stack~~ Temp ~~PID~~ °F | Pump Head Vacuum (in. Hg) | Extraction Well Vacuum (in. $H_2O$) |
|---|---|---|---|---|---|---|---|
| 8/26/1735 | 148 | 0.175 | | | 89.0 | 18 | |
| 8/27/0725 | 161.4 | 0.175 | | | 112.0 | 18.5 | |
| 8/27/1730 | 171.6 | 0.12 | | | 116.0 | 17 | |
| 8/28/0700 | 184.5 | 0.115 | | | 113.2 | 18 | |
| 8/28/0710 | — SHUTDOWN DRAWDOWN CONFIGURATION — | | | | | | |
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Figure 11. Typical Record Sheets for Bioslurper Pilot Testing (Continued)

Bioslurping Pilot Test
(Data Sheet 3B)
Fuel and Water Recovery Data

Page ____ of ____

Site: Griffiss AFB, NY    Test Type:

Start Date: 8.20.96 ~~0020~~ 10:30    Operators: Matt Place, Bob Janosy, Dan Kraft

| Date/Time | Run Time | LNAPL Recovery (volume collected in time period) | Groundwater Recovery (volume collected in time period) |
|---|---|---|---|
| AUG 20 / 1030 | 0 | 0 | |
| AUG 20 / 1800 | 7.5 | NMA | 40 |
| AUG 21 / 0730 | 21 | NMA | 110 |
| AUG 21 / 1900 | 32.5 | NMA | 45 |
| AUG 21 / 0730 | 45.0 | NMA | 60 |
| | | 0 | 255 |
| | | | |
| | | | 5.6 GALLON/HOUR |
| | | | 0.1 GPM. |
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Bioslurping Pilot Test
(Data Sheet 3B)
Fuel and Water Recovery Data

Page ____ of ____

Site: GRIFFISS AFB, NY    Test Type: BIOSLURPER, MW-7

Start Date: 8/22/96  0810    Operators: M. PLACE, B. JANOSY, D. KRA

| Date/Time | Run Time | LNAPL Recovery (volume collected in time period) | Groundwater Recovery (volume collected in time period) |
|---|---|---|---|
| 8/22 /1835 | ~~56.1~~ 10.4 | 3600 mL = .95 GAL | 450 GAL |
| 8/23 /0730 | ~~69.1~~ 23.33 | 300 mL = .10 GAL | 585 GAL |
| 8/23 /1700 | ~~78.6~~ 32.8 | approx. 300-400 mL | 388 GAL |
| 8/24 /0730 | ~~92.7~~ 47.3 | - No MEASURABLE AMOUNT - SHEEN | 652 GAL |
| 8/24 / 0745 | ~~92.9~~ | Shutdown | |
| | 47.6 | | |
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Bioslurping Pilot Test
(Data Sheet 3B)
Fuel and Water Recovery Data

Page ____ of ____

Site: GRIFFISS AFB MW-3 Test Type: Bioslurper

Start Date: 8/24/96 Operators: ________

| Date/Time | Run Time | LNAPL Recovery (volume collected in time period) | Groundwater Recovery (volume collected in time period) |
|---|---|---|---|
| 8-24/0930 | 0 | — | — |
| 8-24/1900 | 9.5 | ~~1.05~~ 1.06 | 454.1 |
| 8-25/0845 | 23.25 | .55 | 680.0 |
| 8-25/1730 | 32.0 | NMA | 419.0 |
| 8-26/0830 | 47.0 | NMA | 704.0 |
| 8-27/0925 | Shutdown configuration in MW3 and switch system | | |
| | back to MW7 | | |
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Bioslurping Pilot Test
(Data Sheet 3B)
Fuel and Water Recovery Data

Page ____ of ____

Site: GRIFFISS AFB, NY MW7 Test Type: Drawdown

Start Date: 8/26/96 Operators: ____________

| Date/Time | Run Time | LNAPL Recovery (volume collected in time period) | Groundwater Recovery (volume collected in time period) |
|---|---|---|---|
| 8/26/0930 | 0 | BEGIN DRAWDOWN | |
| 8/26/1735 | 8.1 | NMA | 100 GAL |
| 8/27/0725 | 21.9 | NMA | 190 GAL |
| 8/27/1730 | 32.0 | NMA | 96 GAL |
| 8/28/0700 | 45.5 | NMA | 155 GAL |
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# APPENDIX E

# SOIL GAS PERMEABILITY TEST RESULTS

| BATTELLE | RECORD SHEET FOR AIR PERMEABILITY TEST | | | | DATE/TIME: |
|---|---|---|---|---|---|
| DISTANCE FROM VENT WELL (ft. & tenths) | | | | | SITE: GRIFFISS AFB, NY |
| TIME FROM START-UP (MIN.) | PT. CODE MP-1 DEPTH 10.0 ft. | PT. CODE MP-1 8.0 ft. | PT. CODE MP-1 6.0 ft. | PT. CODE | RECORDED BY: M. PLACE, B. JANOSY, D. KRAFT |
| | PRESSURE (IN $H_2O$) | PRESSURE (IN $H_2O$) | PRESSURE (IN $H_2O$) | PRESSURE (IN $H_2O$) | COMMENTS |
| 5 | 0.06 | 0.07 | 0.05 | | 8/22/96 |
| 20 | 0.12 | 0.13 | 0.10 | | " |
| 40 | 0.15 | 0.155 | 0.12 | | " |
| 59 | 0.165 | 0.175 | 0.13 | | " |
| 85 | 0.205 | 0.22 | 0.165 | | " |
| 105 | 0.23 | 0.245 | 0.18 | | " |
| 220 | 0.25 | 0.25 | 0.225 | | " |
| 340 | 0.28 | 0.35 | 0.25 | | " |
| 690 | 0.37 | 0.42 | 0.32 | | " |
| | | | | | |
| 0740 | 0.40 | 0.60 | 0.35 | | 8/23/96 |
| 1710 | 0.45 | 0.65 | 0.40 | | 8/23/96 |
| | | | | | |
| 0730 | 0.45 | 0.80 | 0.50 | | 8/24/96 |

| BATTELLE | RECORD SHEET FOR AIR PERMEABILITY TEST | | | | DATE/TIME: |
|---|---|---|---|---|---|
| DISTANCE FROM VENT WELL (ft. & tenths) | | | | | SITE: GRIFFISS AFB, NY |
| TIME FROM START-UP (MIN.) | PT. CODE | PT. CODE | PT. CODE | PT. CODE | RECORDED BY: M. PLACE, B. JANOSY, D. KRAFT |
| | MP-2 DEPTH 8.0 | MP-2 DEPTH 6.0 | MP-2 DEPTH 4.0 | | COMMENTS |
| | PRESSURE (IN $H_2O$) | PRESSURE (IN $H_2O$) | PRESSURE (IN $H_2O$) | PRESSURE (IN $H_2O$) | |
| 5 | 0.025 | 0.025 | 0.02 | | 8/22/96 |
| 20 | 0.065 | 0.07 | 0.055 | | " |
| 40 | 0.06 | 0.05 | 0.04 | | " |
| 59 | 0.055 | 0.06 | 0.045 | | " |
| 85 | 0.10 | 0.095 | 0.08 | | " |
| 105 | 0.10 | 0.095 | 0.08 | | " |
| 220 | 0.13 | 0.135 | 0.105 | | " |
| 340 | 0.14 | 0.15 | 0.12 | | " |
| 690 | 0.22 | 0.215 | 0.171 | | " |
| | | | | | |
| 0740 | 0.19 | 0.205 | 0.185 | | 8/23/96 |
| 1710 | 0.20 | 0.20 | 0.20 | | 8/23/96 |
| | | | | | |
| 0730 | 0.25 | 0.25 | 0.25 | | 8/24/96 |

| BATTELLE | RECORD SHEET FOR AIR PERMEABILITY TEST | | | | DATE/TIME: |
|---|---|---|---|---|---|
| DISTANCE FROM VENT WELL (ft. & tenths) | | | | | SITE: Griffiss AFB, NY |
| TIME FROM START-UP (MIN.) | PT. CODE MP-3 DEPTH 10.0 ft. | PT. CODE MP-3 8.0 ft. | PT. CODE MP-3 6.0 ft. | PT. CODE | RECORDED BY: M. PLACE, B. JANOSY, D. KRAFT |
| | PRESSURE (IN $H_2O$) | PRESSURE (IN $H_2O$) | PRESSURE (IN $H_2O$) | PRESSURE (IN $H_2O$) | COMMENTS |
| 5 | 0.015 | 0.015 | 0.015 | | 8/22/96 |
| 20 | 0.060 | 0.055 | 0.06 | | " |
| 40 | 0.015 | 0.025 | 0.015 | | " |
| 59 | 0.02 | 0.02 | 0.02 | | " |
| 85 | 0.06 | 0.065 | 0.06 | | " |
| 105 | 0.065 | 0.07 | 0.07 | | " |
| 220 | 0.085 | 0.08 | 0.085 | | " |
| 340 | 0.068 | 0.08 | 0.078 | | " |
| 690 | 0.121 | 0.118 | 0.123 | | " |
| | | | | | |
| 0740 | 0.105 | 0.105 | 0.105 | | 8/23/96 |
| 1710 | 0.105 | 0.11 | 0.12 | | 8/23/96 |
| | | | | | |
| 0730 | 0.14 | 0.14 | 0.14 | | 8/24/96 |

# APPENDIX F

# IN SITU RESPIRATION TEST RESULTS

## Record Sheet for In Situ Respiration Test

Site: GRIFFISS AFB, NY
Monitoring Point:
Shutdown Date: 8/27/96
$O_2/CO_2$ Meter No.:
TPH Meter No.:
Shutdown Time: 0734
Recorded by: M. PLACE, B. JANOSY, J. THOMAS

| Date | Time | $O_2$ (%) | $CO_2$ (%) | TPH * (ppm) | He (%) | Temperature ~~(°C)~~ °F | Comments |
|---|---|---|---|---|---|---|---|
| 8/27/96 | 0740 | 20.5 | 0 | 320 | 2 | — | MP1 10.0 ft |
| " | " | 20.5 | 0 | 0 | 2.4 | 69.2 | MP2 8.0 ft |
| " | " | 20.5 | 0 | 32 | 2.3 | — | MP3 10.0 ft |
| " | 0840 | 19.0 | 0 | 1400 | 2.2 | — | MP1 10.0 ft |
| " | 0840 | 20.0 | 0 | 48.0 | 2.4 | 66.4 | MP2 8.0 ft |
| " | 0840 | 20.0 | 0 | 400 | 2.4 | — | MP3 10.0 ft |
| " | 1010 | 19 | 0 | 640 | 2.4 | — | MP3 10.0 ft |
| " | 1010 | 19 | 0 | 96 | 2.3 | 67.2 | MP2 8.0 ft |
| " | 1010 | 17.5 | 0 | 2000 | 2.0 | — | MP1 10.0 ft |
| " | 1245 | 15.0 | 0.2 | 3000 | 2.1 | — | MP1 10.0 ft |
| " | 1245 | 18.0 | 0 | 180 | 2.3 | 66.4 | MP2 8.0 ft |
| " | 1245 | 18.0 | 0 | 1000 | 2.2 | — | MP3 10.0 ft |
| " | 1740 | 12.0 | 0.5 | 3800 | 2.0 | — | MP1 10.0 ft |
| " | 1740 | 16.0 | 0.4 | 160 | 2.2 | 67.2 | MP2 8.0 ft |
| " | 1740 | 16.5 | 0.5 | 1600 | 2.3 | — | MP3 10.0 ft |
| " | 2240 | 10 | 0.5 | 4200 | 2.1 | — | MP1 10.0 ft |
| " | 2240 | 14 | 0.5 | 460 | 2.3 | 68.2 | MP2 8.0 ft |
| " | 2240 | 15 | 0.5 | 1800 | 2.3 | — | MP3 10.0 ft |

* TPH METER ACTING UP – READINGS BOUNCING AROUND

Record Sheet for In Situ Respiration Test

Site GRIFFISS AFB, NY

Shutdown Date

Shutdown Time

Monitoring Point

$O_2/CO_2$ Meter No.

TPH Meter No.

Recorded by M. PLACE, B. JANOSY, J. THOMAS

| Date | Time | $O_2$ (%) | $CO_2$ (%) | TPH (ppm) | He (%) | Temperature ~~(°C)~~ °F | Comments |
|---|---|---|---|---|---|---|---|
| 8/28/96 | 0700 | 5.5 | 0.75 | 6000 | 2.0 | — | MP1 10 ft |
| " | 0700 | 11.2 | 0.6 | 760 | 2.4 | 68.2 | MP2 8 ft |
| " | 0700 | 12 | 0.6 | 3200 | 2.4 | — | MP3 10 ft |
| " | 0945 | 4.0 | 0.75 | 5800 | 1.8 | — | MP1 10 ft |
| " | 0945 | 10.5 | 0.7 | N.R. | 2.3 | — | MP2 8 ft |
| " | 0945 | 11 | 0.7 | 3200 | 2.4 | — | MP3 10 ft |
| " | 1145 | 3 | 0.8 | 5800 | 1.8 | — | MP1 10 ft |
| " | 1145 | 10 | 0.75 | 900 | 2.3 | — | MP2 8 ft |
| " | 1145 | 10 | 0.70 | 4000 | 2.3 | — | MP3 10 ft |
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